NEW INSIDE- COMPUTING TODAY!

eti

ELECTRONICS TODAY INTERNATIONAL

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UHF TV antenna to build

S100 'universal' PROM board

Technics' RS-M51 cassette review

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QUICK INDEX

THIS MONTH you will notice we have made a few changes to the magazine. Firstly, we've rationalised our coverage of the computing scene and have introduced a formal section called COMPUTING TODAY! The signs of increasing interest and demand for information in this area have become so strong in recent months that we just had to do something concrete about the subject. The old favourite 'Printout' news column continues and we have included additional material in the way of features and a project. We hope you find the section interesting and informative — in any case, we'd like to know what you want so don't hesitate to write and let us know!

This month we cease publication of the 'Shortwave Loggings' column and the Ionospheric Predictions. It seems the boom in interest in this sector has levelled out over the past 12 months. In addition, at least three other magazines — including two specialist magazines — are publishing material monthly (not to mention several 'underground' publications) and duplication seems pointless. However, we were the first to introduce the GRAFEX style of ionospheric predictions, courtesy of the Ionospheric Prediction Service of the Department of Science and Technology, which we note is now used by other publications. What was that about the sincerest form of flattery . . . ? The Shortwave Loggings column was ably written by Peter Bunn of the Australian Radio DX Club, to whom we are very grateful for the abundance of good material, always supplied on time. However, we will publish articles and projects covering the communications scene from time to time, and we have retained the Communications News column.

Next month will be our tenth birthday issue — for a preview, turn the page!

Roger Harrison

Roger Harrison
Editor

advertisers

eti ELECTRONICS TODAY INTERNATIONAL

Need we say more? Cover photograph taken in a Sydney suburb during the operation of a police radar trap. Photo by John Knight, cover design by Ivy Hansen.

*Recommended retail price only

features

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In this new section you'll find all the 'hot' news in the field of personal computing.

BEHOLD—THE BUBBLE MEMORY!   89
There is a gap between cheap, fast semiconductor memories and the slower, huge capacity, mass storage, magnetic memory media. Bubble memories, a relatively new technology, may be all set to bridge the gap.

BACK DOOR INTO BASIC   108
In this fourth part of Phil Cohen's painless introduction to BASIC, he shows how the knowledge so far built up by the reader can be used to write and understand useful programs.

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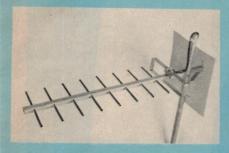
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AIR IONISERS — FACT AND FICTION
Some phenomenal benefits are claimed for negative ion generators but just what they do and why they work is shrouded in myth, scepticism and strange jargon. Our correspondent attempts to clear the air a little . . . no pun intended! An extensive bibliography is included.

EXPERIMENTAL AIR IONISER
For those experimenters who just *have* to find out for themselves Jonathan Scott has devised a *safe* negative ion generator project for you to play with. This unit can be made from commonly available parts, is powered by a plug pack or 12 V battery (you can run it in your car!) and is inexpensive to build.

INFRA-RED REMOTE CONTROL
The convenience of being able to remotely control mains-operated equipment should be apparent to every red-blooded electronics enthusiast. This simple-to-build unit employs an infra-red link that cannot be 'fooled' by spurious infra-red emissions such as from cigarette lighters, etc. The portable transmitter can be readily carried in your pocket and the controller can operate equipment drawing as much as 5 A from the 240 Vac mains.
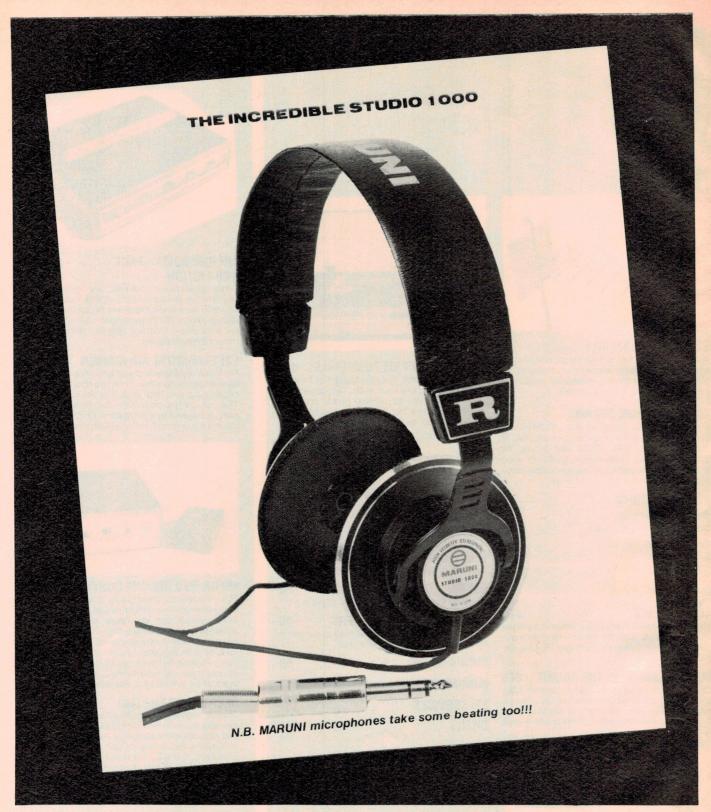
SECRETS OF THE Z80!
The Z80 is generally recognised as being just about the most powerful 8-bit micro around. Zilog's literature describes its repertoire as having 158 types of instructions with a total of 696 possible opcodes (plus data). This should be enough for anyone — but there are 88 more usable opcodes, did you know!? This article explains what they are and why they exist, as well as how to check to see if your TRS80 has them.

KENWOOD KR-80 FM/AM RECEIVER
A recent release from Trio-Kenwood, Louis Challis reckons ". . . This is without doubt one of the neatest and most exceptional receivers that I have yet tested."

Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.

What's new, pussycat-san?

When it comes to electronic entrepreneurism, the Japanese rush in . . . and the rest of the world trundles along behind. Or so it seems. Late last year, Dennis Lingane went to Japan's prestigious audio and electronics shows. Here's his account.

From TV screen to four-colour hard copy — in two minutes.

"You may remove your cup now. Have a nice day," said the hot drinks machine. I dutifully removed the cup, took a sip, and said **"Thank you"** before I realised what I was doing — talking to a machine!

Looking sideways to see if anyone had noticed, I shuffled off clutching the steaming hot cup of coffee. But I needn't have worried; all the people around me were totally immersed in the gimmicks and marvels and gadgets on show in the electronic wonderworld of the Tokyo International Electronics Show.

It was like something out of 2001. Robots walked and talked, as well as my coffee machine; artists drew pictures on TV screens with a light pen and minutes later the picture was reproduced in hard copy from a four-colour facsimile machine; in the Mitsubishi stand a computer-controlled sewing machine was embroidering a satellite picture on a piece of cloth straight off a TV screen; a five-foot speaker was pushing out a 5 Hz signal; the list of electronic wizardry could go on and on.

Even the massive domed exhibition building made you feel as if you'd stepped into outer space, with its great dome studded with pin-points of light set into a complex criss-cross of superstructure. There were six buildings altogether, two of which housed the All Japan Audio Show, and another which
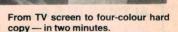
Radio control models had a whole building to themselves!

was devoted to radio-controlled models: cars, helicopters, aeroplanes and boats rushed around showing off their tricks — and occasionally bumping into each other — as thousands of eager Japanese enthusiasts crowded the stands to see them.

The space-age electronics building was really the star of the show, however, and the biggest attraction there this year was the voice-controlled houses, exhibited by both Sharp and Sanyo. Sanyo opened curtains, windows, doors, made coffee and toast, and even ran a bath by means of commands through a telephone, while in Sharp's house you could simply walk through issuing commands and watch the furniture and fittings leap to do your bidding. Quite how readily this somewhat unnerving domestic

management will be accepted by many people is perhaps questionable, but it will certainly be a boon to the handicapped, who will be able to run a household from a chair or bed. The system can be programmed to recognise only specific voices, so the security aspect is also taken care of.

Dozens of white-coated scientists and technicians stood around ready to answer any more complex questions; I was unwise enough to enquire how Matsushita's 3D TV worked. Having established my credibility, found enough Japanese scientists who wanted to practise their English, ushered me off to a VIP room and fortified us all with Cokes, the Japanese then unveiled the secret of this TV marvel — a pair of electronic glasses! These

plug into the side of the TV set, two cameras take it in turn to transmit pictures, and as they are constantly switched on the TV screen the glasses' electronic shutters synchronise with the flickering picture. I was about to make some witty remarks about this cumbersome system when they informed me that the National TV station NHK plans to do test transmissions later this year!

Possibly the craziest talking machine at the show was the sultry lady's voice you can have built into your dashboard to do the back-seat driving for you. In NEC's customised Porsche this sexy voice would pipe up with a warning every time you looked like doing something wrong: "You're going too fast"; "You need petrol, darling"; "The engine needs oil, sweetie". Let's hope they never discover Jeannie Little!

On the video scene there were of course lots of new developments and gimmicks, but my favourite was the new JVC zoom microphone. This mounts on top of your camera and changes from an omnidirectional to a shot-gun mike as you zoom from wide angle to close-up on the camera lens. It really works; in a demonstration of its effectiveness JVC filmed a couple of people talking in a busy street. On the wide-angle shot the traffic noise was so loud you couldn't hear the people talking, but when they used the

zoom lens on the two people the microphone zoomed in as well, and the conversation became clear, losing all sounds of traffic.

It works by use of three elements, one with 180° range facing forwards, another one facing backwards, and a third super-directional element. On wide angle the two 180° elements operate; when you zoom in on a subject, the backward-facing element cancels out and the super-directional one takes over. At the same time there is a 12 dB boost in sensitivity. When this mike is released commercially it will surely be an absolute burster in the home video market.

Still on video, Sony had a prototype solid-state camera at the show, in which the picture tube is replaced by an electronic

sensing device. When these are in production it will only be a step to the combined recorder-camera with a mini-cassette housed in the camera body. Hitachi and Matsushita are also working on such models.

Dazzled by all these electronic wonders, I retreated into Tokyo

JVC's zoom microphone that can be clipped to your video camera.

in an attempt to get back to reality and 1980. But everyday Japan doesn't seem so very different from the show: overhead monorails swish by you;

down in one of the southern islands there is a magnetic levitation train that travels at over 500 km/h; practically everyone in the street carries a portable cassette player hooked to their belts, earphones clamped on their heads (reminiscent of the transistor radio craze back in the Fifties); and in Akihabara, the electrical heart of Tokyo with 200 stores selling just electrical and electronic goods, the six-lane street is shut off on Sundays and used for racing mini radio-controlled racing cars. Overhead hover radio-controlled helicopters, and on the pavements young lovers stroll and window-shop for their new electrical appliances: an electric carpet that plugs into the mains to keep your feet warm in winter, or

maybe a microwave oven with smell, smoke and vapour sensors so it knows when to switch off!

When you come down to it, the electronics show is really only an extension of a society that is already locked into the technological age — with enthusiasm.

Dennis Lingane

Lingane having a brainstorm on the Fuji stand!

Keeping up with the Japanese Joneses

Sitting back here in Australia it is difficult to try and place the Tokyo Electronics and Audio Show into any sort of sane perspective.

The Japanese have long had a tendency to self-indulgence when it comes to new electronic whims — in particular to the tricks-and-gimmicks whims of their Research and Development departments. Consequently, 80 per cent of all Japanese sales are now motivated by R & D, with predictable consequences.

The scientists and technicians who in the past lived in a kind of electronic Utopia now find that they are the main influence on the marketplace, all because Japanese consumers have become accustomed to being able to buy all the latest gadgets, and now want them and are prepared to pay the money for them. So if a company's product doesn't have that latest gimmick it has to do something pretty smartly about producing a product that has — and preferably some new 'feature' as well.

The result is that a new model has about six months on the market before another Japanese manufacturer comes up with a newer product with a few more tricks that supersedes it in the consumers' eyes.

While the Japanese manufacturers are thus falling over each other with constant innovation for the home market (50 per cent of everything made in Japan is sold there — where do they put it all on those tiny islands?), it is playing havoc with their overseas markets.

In Australia it takes the average consumer about six months to make up his mind to buy. When he finally returns to the store he finds that the unit he had decided on is now obsolete and a new model has taken its place. It makes him restless and insecure because he cannot possibly hope to keep up with all this innovation, and he is forcibly made to realise that the money he is about to part with is being spent on an item that has every chance of being obsolete in six months.

Australian dealers are also unhappy about this Japanese trend for constant novelty because it often takes them six months to get a product rolling in this country. Just when it has become a demand item, production is stopped.

This demand for 'tricks' and the consequent high product obsolescence is also having a bad effect on many Japanese manufacturers. Those who have not invested in the 'chip technology' are only just struggling along; the only companies that can write their own trick routines are those with LSI and VLSI technology at their

disposal. As well as this, the Japanese consumer seems now to have a philosophy that the sound he is getting from his audio products is 'good enough', and consequently it is the tricks and gimmicks again which sell products.

As a result, many traditional audio manufacturers who have always put good sound before gimmicks are feeling the pinch in this new wave of electronic consumerism.

It is against this somewhat hysterical and gloomy backdrop that the Tokyo Electronics and Audio Show has to be viewed. Predictably, there is no lack of interest from the public; in 1980 the gate into the audio shows (which one pays to enter) exceeded 360 000 — 100 000 up on the previous year.

This annual electronic Disneyland is *the* opportunity for the Japanese manufacturers to show off their new products to the public and to gauge reactions — and of course to spy out other companies' prototypes and consumer reaction to them.

Screeds of reports are written, and then it's back to the various companies' R & D departments for them to start work on producing a similar prototype. This means that practically every company in Japan has a prototype of a similar new product. They watch each other like hawks to see who is game to do a market test first. If someone breaks away from the pack (as Sony did with its Walkman portable cassette), he can make a killing (before the others get in on the boom) if the product takes off. If it doesn't, he's left with egg on his face. All this explains why every Japanese manufacturer seems to come out with a new design at the same time.
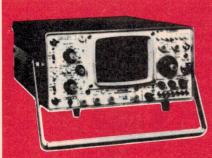
European and American companies as yet tend to operate in a different manner. They look for an area of the market that appears to be going begging and develop a new product to fill it. After it is launched it takes everyone else, often even the Japanese, at least twelve months to catch up because all the companies were not doing the basic groundwork for the same kind of product at the same time. This seems a far more constructive approach to marketing and one in which the consumer gets a chance to buy a product without feeling caught in an unending spiral of novelty.

There is a saying in Japan: "There's only one way to do things in Japan — that's the Japanese way". It's to be hoped that electronics can avoid the day when its motto is: "There's only one way to do things in the world — the Japanese way".

Dennis Lingane

DMMs — portables on the run

Handheld LCD display digital multimeters are appearing on the local market with increasing frequency of late. There's plenty of variety and a wide range of features to choose from.
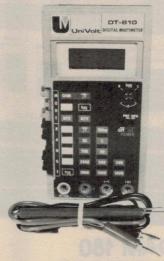
First cab off the rank is Beckman's new top-line portable, the 3½-digit RMS 3030. This one touts true RMS (ac + dc) measurement capability, unlike most analogue and many digital instruments which simply measure the average and then add an 11% scale factor. The RMS reading is only 'true' then for sinewave signals.

All that apart, the RMS 3030 has guaranteed accuracy for all ac ranges to 20 kHz for signals with crest factors from 1:1 to 5:1 (peak/RMS). Measurement accuracy extends from ±0.6% of reading at 45 Hz to ±2% at 20 kHz. The unit is similar in style to the 3010 and 3020, and like them features 22 M input impedance, continuity indicator, semiconductor test function and internal RF shielding. Battery life is quoted as 2000 hours. Distributors are Warburton Franki, branches in all states.

Second runner is new to the field, the Univolt DT-810. Also a 3½-digit instrument, it sports five dc voltage ranges from 200 mV to 1kV, two ac voltage ranges (200 V and 1 kV), five dc current ranges from 200 μA to 10 A plus four resistance ranges from 2 k to 2 M. In addition, it features a conductance checker with audio beeper plus bright, colour-coded panel markings. Also included is a semiconductor test facility which can be used to measure transistor hFE between 0 and 1000.

The Univolt instrument is distributed by IFTA, P.O. Box 21, Bondi Beach NSW 2026. (02)665-8211.

Third one up is Kaise and the distributors. Standard Com-

ponents of 10 Hill St, Leichhardt NSW, have just introduced four LCD display DMMs, all sporting auto-ranging. The four meters differ only in having optional 10 A ac/dc current ranges and an audio beeper continuity checker. The two models including this feature also employ the beeper as an overload indicator. Full details on the range from Standard Components.

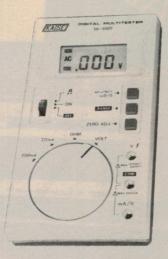Whilst we're on the subject, we'd like to editorialise for a moment. We've noticed a distressing tendency for manufacturers to include probes with their instruments which do not have a finger guard, the purpose of which is to prevent your pinkie from sliding down the probe and possibly touching a dangerous voltage, thus eliminating you as a customer. This practice is bad for maker and user alike. Check this when buying **any** multimeter. Buy a set of finger-guarded probes if they aren't supplied.

ERRATA

In **Lilliput Computers** in the January issue, there is a typographical error in the program listings on page 73. In the 'Great Circle' program, line 720, J$D=DEG D, should read J$:D=DEG D. In line 750, the 'COX' in the equation should be COS.

In the **ETI-477 MOSFET amplifier module** in the February issue, under How It Works, there is a typographical error in the second last sentence, third column. It reads: "Transistors Q4 and Q5 therefore form the main voltage gain section of the amplifier . . .". It should read: "Transistors Q6 and Q8 . . .".

Appointments, people and products

University Graham Instruments, the Sydney-based meter and instrument manufacturer, late last year appointed Carew Northcote as Sales Manager covering their complete range of products. Mr Northcote has spent almost 30 years in the trade. Alan Jeffrey is now Manager of University's Melbourne office.

Ike Bain, formerly General Manager of Dick Smith Electronics, has been appointed Managing Director of the Dick Smith Group. Ike joined the company in 1972 and has been General Manager since 1975. Dick Smith remains Executive Chairman.

Vicom International, Melbourne-based communications equipment and instrument importer, has appointed Phil Fitzherbert as Regional Sales Manager for NSW, ACT and the Northern Territory, effective 1 February this year. Phil will be based at Vicom's Sydney office at 339 Pacific Hwy, Crows Nest. Forsaking his old call VK3FF, Phil now sports VK2IN. This means that when he's on the channel 8 repeater, he's IN and you're out! Phil is a graduate engineer (RMIT) and comes with a strong sales background. Vicom aim to increase their profile in NSW.

Philips Electronic Components & Materials and Sycom, the Australian marketing Division of Systems Reliability (Aust) Pty Ltd, have recently entered into a distribution arrangement. Sycom will actively merchandise a Philips/Signetics/Dialight/Airpax product portfolio which includes semiconductors and ICs, capacitors, hi-fi loudspeakers and kits and electromechanical devices. Sycom will distribute throughout Australia from their present locations in Sydney and Melbourne.

Toshiba Corporation in Japan has recently announced the appointment of Promark Electronics Pty Ltd as Australian distributor of their extensive semiconductor product range. The appointment followed months of negotiations which culminated in a visit to Toshiba's headquarters in Tokyo by Chris Leitch, joint Managing Director of Promark. In order to cope with the substantial increase in business volume that Toshiba semiconductor products will generate, Promark will be recruiting additional staff for its Sydney headquarters and Melbourne sales office during 1981. Agents are to be appointed to handle sales in other states and major country centres.

C & K Electronics (Aust.) has appointed GHE Electronics, Argyle Street, Hobart (34-2233) and GHE Electronics, York Street, Launceston (31-6533) as its Agent for Tasmania. GHE Electronics is a Division of George Harvey Electronics Pty Ltd of Tasmania.

Power to the people !

When power is dissipated in a circuit, inevitably, things get hot. Especially resistors.

Power resistors present problems in many places because you've got to get rid of the heat without affecting nearby components. When you've got to get rid of a lot of heat, conventional-style wirewound resistors get quite large. And quite hot. Many are rated to run at temperatures up to 200°C.

Metal-clad wirewound resistors are the solution but they've traditionally been hard to get in Australia.

An Adelaide company, Everest Electronics, has come to the rescue and advise they are stocking the British-made Arcol HS range of metal-clad power resistors in heatsink, chassis and free-air mounting styles.

Values stocked conform to the E24 range, plus R05 (0.05 ohms), R25 (0.25 ohms) and R5 (half ohm), in power ratings of 10, 15, 25, 50, 75, 100, 150, 200, 250 and 300 watts. Standard tolerance is ±5%, ±10% in the low values. Non-inductive types, vertical mounting types and other tolerances are available on order.

Pricing is competitive; e.g: HS15 values (15W) are $2.80 each, HS25 $3.20 each and HS50 are $3.70 (plus 15% sales tax, if applicable). Full technical details and stock lists available from Everest Electronics, 61 Compass Drive, Seaford S.A. 5169. (08)386-1554.

Car stereo switch

This car stereo-radio speaker switch enables you to use your best speakers for both your radio and stereo. The switch suits negative (earth grounded) and above-ground speaker systems. It also has many other audio and CB uses.

Swann claim that there is no soldering required as all wires are presoldered and the handyman need only splice or screw the ends of the wires to his or her sound system.

For other Swann products ask for the new Swann Automotive catalogue — a comprehensive booklet of all Swann's automotive accessories. Swann Electronics International Pty Ltd, P.O. Box 350, Mt. Waverley, Vic. 3149. (03)544-3033.

Police radar traps
— are not infallible!

The fallibility of the police radar units used in speeding cases has recently been publicly called into question in a NSW court case. Jon Brereton examines the units themselves from a technical viewpoint, and comments on the repercussions of these technicalities for the police, the public and the courts.

Jon Brereton

A GREAT DEAL of comment has been passed over the years that police radar has been in service, both in Australia and the US. Most of this has been directed against the radar instruments or their operators, but most of it has also been made by journalists with little or no technical expertise in the field and with no account taken of the correct operating procedures as taught to police operators. Radar speed traps are now no longer accepted as conclusive proof of guilt in many places, and they

are coming in for a lot of flak in NSW at this time. This article describes the exact electronic operation of both the older X-band Digidars and the new K-band KR-11 traps, and outlines how these units are open to error and abuse. It also discusses the difficulty involved in legally dealing with matters where high technology is in question.

The unit which has been primarily used by the NSW Police until recently is the Digidar I. This series of units was designed and made for the Smith and

Wesson company about 20 years ago. They operate on the lower band assigned to radar units, the so-called X-band, around 10.5 GHz. Due to their age of design they employ SSI TTL ICs, and so are formed of the usual counter/latch/gate level ICs which were at the forefront of technology at the time. The circuitry can be cut into blocks fairly easily and in a number of ways. Figure 1 shows a functional block diagram which is not complete in its detail but which includes all that is necessary to see the

significant points of operation.

The antenna is a relatively simple dipole mounted in a dish-shaped reflector which gives an elliptical beam. This is mounted in a convenient place — in NSW the window of the patrol car. The beam shape is of course modified, but this does not seem to be serious. The free space beam width (3 dB power points) is 6°, and the actual beam width when so mounted somewhat less than double this, in a typical situation.

As well as the antenna in the head assembly are an oscillator and a mixer, and an audio amplifier. The oscillator and mixer are separate and connected by suitable hardware to the dipole, but function similarly to the single-casting types available today, returning a low level audio signal which is the difference between the transmitted and received frequencies. By the well-known Doppler principle, this tone is proportional to the velocity of the object which has reflected the signal, at the rate of about 19.5 Hz per mile per hour (about 31.4 Hz per kilometre per hour). When more than one mobile reflector contributes to the return, the output is the algebraic sum of the audio tones, one corresponding to each return.

The audio amplifier consists of two transistors and a 741 op-amp. These provide high gain and a crude filtering function which rolls off frequencies below a few hundred Hertz and above a couple of kiloHertz. The upper frequency limit is determined by the capabilities of the op-amp.

This audio is then passed through a cable to the main console where it is passed through a gain control to another op-amp. This is connected as a zero crossing detector with a small amount of hysteresis: i.e: Schmitt trigger set at about the average of the audio tone. This stage has a squared-off output which is subsequently fed to a monostable to sharpen it up for the TTL logic. The Schmitt trigger stage has a most interesting effect on the signal when the incoming tone is complex. It returns a pulse train which, averaged over a suitable period, as we will later see happens, has the same number of transitions as the dominant signal, even though that dominant signal may be only 1 dB above the next strongest contributing component. To explain further, it effectively and efficiently

About the author:

Jon Brereton has degrees in Physics and Engineering, as well as experience with both digital electronics and microwave techniques. He also has experience with both radar traps and the counter measures, and as an independent consultant has analysed performance of the Digidar and KR-11 units.

The Digidar 1, manufactured by Smith and Wesson and currently used by the NSW police. Figure 1, below, is a block diagram of this machine.

filters out the strongest return signal as received by the antenna assembly. Only when the two or more most intense returned signals are within that tiny fraction of the dynamic range represented by 1 dB will the op-amp's output have a changing number of transitions on subsequent averaging periods. The significance of this will become obvious later.

The pulse train is counted after the fashion of a DFM. Starting at the beginning of a pulse, in order to ensure that each successive count period starts at the same phase point on the incoming signal, the timebase opens the gate for 51.3 ms, which allows the accumulation of that number of pulses which will cause the display to read directly in miles (or kilometres if the unit is so modified).

When the accumulation is complete, a comparison is made between the contents of the counters and latch #1. If this shows equality, the occurrence counter is incremented, and if not it is reset. The contents of the main counter are then latched into latch #1. Finally the counters are reset, and, if an input signal is still present, another count cycle commences. When six sequential counts agree it is signalled by the occurrence counter signals and latch two copies latch one, displaying the speed count. The contents of latch #2 are then compared to the preset speed on the thumbwheel switches, and if it exceeds the 'speed minder' setting the violate light is illuminated and the
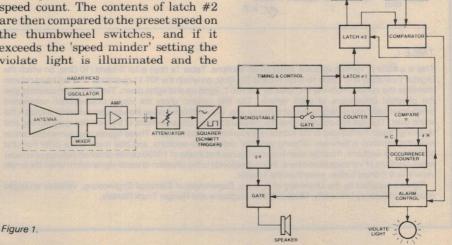
divided audio tone is passed to the loudspeaker. Two seconds later, unless the device has been set to hold the count, the display is reset. If the incoming pulse train changes its fundamental frequency, as counted over the gate open period while the display is enabled, latch #2 is reset showing a 'double zero' count.

The operator of a Digidar is instructed not to take any action unless certain conditions are met: there must be one vehicle clearly closer to the unit's receiving head and it must have a clear and unobstructed line of sight to the head; the tone must be clear and unbroken, and the speed reading must be steady for two seconds. These conditions are supposed to ensure a positive or 'good' measurement of a vehicle's speed.

Possibilities of failure

Let us now consider some of the potential modes of failure of this approach to speed measurement.

Firstly there is a small but finite probability that two incoming signals will combine to give six sequential readings of a completely erroneous nature, as the unit pays no heed to the ►

Figure 1.

MEASURED RADAR CROSS-SECTIONS OF A VARIETY OF VEHICLES

1a X-BAND RESULTS — CORRESPOND TO DIGIDAR

VEHICLE	VISUAL DIMENSION		MAX. AREA sq. metres	AREA COMPARED TO KOMBI AREA	APPROACHING RADAR CROSS-SECTION*	DEPARTING RADAR CROSS-SECTION*
	width (in mm)	height (in mm)				
Kenworth truck	2502	4115	10.3	3.74	14.58	40.5
Hyno truck	2438	3600	8.64	3.14	6.5	3.3
Inter Acco 3070 truck	2438	2374	5.8	2.1	5.2	2.12
V.W. Kombi van	1680	1640	2.755	1	1	1.4
Datsun MQ Patrol	1690	1608	2.717	0.98	0.014	2.05
Ford XD Falcon	1860	1242	2.31	0.84	0.08	1.74
Peugeot 505	1720	1330	2.29	0.83	0.003	0.09
Citroen Goddess	1720	1260	2.17	0.79	0.008	0.03
Volvo 144 GS.	1735	1240	2.15	0.78	0.2	1
Honda Civic (wagon)	1580	1242	1.96	0.71	0.3	0.17
Leyland Mini	1440	1350	1.94	0.71	0.1	0.08
Holden Gemini TE (wagon)	1570	1189	1.87	0.68	1.19	0.27
Mazda RX 7	1670	1105	1.84	0.67	0.005 0.02**	0.2
Honda S600 convertible	1400	970	1.36	0.49	0.17	0.35
Motor bike — Honda 650/4	775	1720	<1	0.36	0.006	0.008

* TAKING RETURN FROM KOMBI FRONT AS UNITY REFERENCE

** WITH RAISED HEADLIGHTS

ratio $\frac{max}{min}$ radar cross-section = 13,500

$\sqrt[4]{}$ = 10.8.

1b K-BAND RESULTS — CORRESPOND TO KR-11.

VEHICLE	VISUAL DIMENSION		MAX. AREA sq. metres	AREA COMPARED TO KOMBI AREA	APPROACHING RADAR CROSS-SECTION*	DEPARTING RADAR CROSS-SECTION*
	width (in mm)	height (in mm)				
Kenworth truck	2502	4115	10.3	3.74	10.23	143.8
Hyno truck	2438	3600	8.64	3.14	2.9	1.2
Inter Acco 3070 truck	2438	2374	5.8	2.1	16	7.85
V.W. Kombi van	1680	1640	2.755	1	1	0.64
Datsun MQ Patrol	1690	1608	2.717	0.98	0.64	9
Ford XD Falcon	1860	1242	2.31	0.84	0.25	0.3
Peugeot 505	1720	1330	2.29	0.83	0.16	0.06
Citroen Goddess	1720	1260	2.17	0.79	0.36	0.16
Volvo 144 GS.	1735	1240	2.15	0.78	0.25	0.25
Honda Civic (wagon)	1580	1242	1.96	0.71	0.36	0.25
Leyland Mini	1440	1350	1.94	0.71	0.16	0.12
Holden Gemini TE (wagon)	1570	1189	1.87	0.68	0.64	0.16
Mazda RX 7	1670	1105	1.84	0.67	2.7 0.36**	0.12
Honda S600 convertible	1400	970	1.36	0.49	0.49	0.16
Motor bike — Honda 650/4	775	1720	<1	0.36	0.06	0.16

* TAKING RETURN FROM KOMBI FRONT AS UNITY REFERENCE

** WITH RAISED HEADLIGHTS

ratio $\frac{max}{min}$ radar cross-section = 2396

$\sqrt[4]{}$ = 7.

TABLE 1.

This is a table of various vehicles' radar cross-sections. Table 1a (top) is for X-band (10 GHz, on which the Digidar operates) and Table 1b is for K-band (24 GHz, on which the KR-11 operates). The left hand column identifies the vehicle; note the two rows for the RX-7, lights up and lights down. The next three columns give the physical dimensions of each vehicle. The fifth column gives the visual cross-section normalised (mathematically compared) to that of a Kombi van. We did this because the ubiquitous Kombi is known the world over. The last two columns give the measured radar cross-sections of the vehicles approaching and receding, again normalised to the Kombi (approaching) cross-section. These figures give some idea of how wide the variation is between differing vehicles' radar cross-sections, and how much these differ from the optical cross-sections. It can be seen from the figures that a ratio of 13500 can be obtained between the radar cross-sections of vehicles tested here: this corresponds to the situation of equal signal return when the larger vehicle is 9.5 times further away than the smaller.

The Inter Acco 3070 truck used in our measurements was kindly loaned to us by Ranger Rentals, cnr Berry St and Parramatta Rd, Granville NSW. 682-4000.

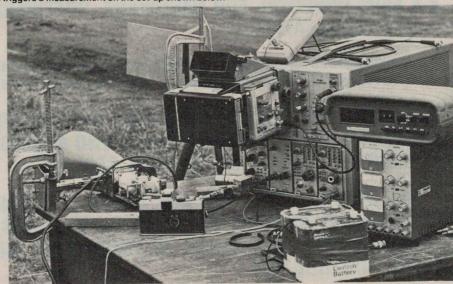This photograph shows an actual measurement under controlled conditions of a situation similar to that described in Figure 2, below. The Mazda RX-7 in the front was driving at 25 kph while the truck behind it was travelling in excess of 65 kph. At the time this picture was taken the truck was several hundred metres behind the Mazda. The radar unit we used (electronics similar to the KR-11) clocked the truck's speed exclusively. The tripod at right carries a laser, the tripod at left a photodetector. A vehicle breaking the beam triggers a measurement on the set-up shown below.

constancy of the mark to space ratio of the pulses within an averaging period. Numerical simulation by computer shows that in a stable situation this will occur less than 1% of the time, and has a tendency to occur if the second signal is several dB lower in amplitude and much higher in speed. It is also more likely if there is a harmonic relationship between the signals at the audio level. The tone would be constant and unbroken, though not 'pure'; this last would be camouflaged by the inherently harmonic nature of the squared tone fed to the speaker in any case. However, the probability of getting such a situation to remain stable long enough for a reading and tone to be acceptable is incredibly small. Thus we can almost discount this mode of failure.

It is worth noting here that the radar unit itself gives a strong feeling of infallibility to the operator. It remains silent until it reads a speed. Then it

Equipment used to measure the radar cross-section of vehicles at 10 GHz (X-band) and 24 GHz (K-band). The doppler audio output from the radar head was displayed on the CRO. The Polaroid CRO camera was triggered when the light beam (see above picture) was broken by the vehicle being measured. Signal strength readings were scaled from the film to obtain the radar cross-section. The X-band head is at rear left, the K-band head is hidden behind the CRO camera. A radar unit, similar to the Digidar, is at front right.

displays it for two seconds. Only very rarely does the double zero appear (as we might expect from the delicateness of the filtering function). The tone is, by nature of its method of development, level in amplitude and it also reflects the almost complete rejection of lower signals which the filter effects. Operators can almost be forgiven for assuming that the units cannot make mistakes.

The second mode of failure is from outside the device, and is a consequence of the principle of 'choosing the strongest return' as a whole. This concerns the 'radar cross section' of differing vehicles. The radar cross ▶
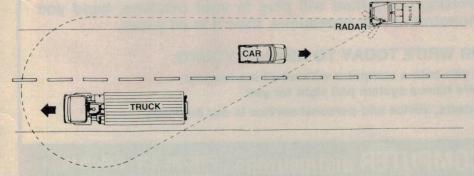

Figure 2. Truck (moving either way) returns more signal than the car, overpowering its return. An operator may book the car when in fact the truck's signal is being selected. Establishing a good 'tracking history' can often stop this, but this is unreliable, especially with the unit used in lock mode, which halts the display when one violate reading is made.

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section of a target is a measure of the reflectivity of that target as perceived by the instrument at the frequency of operation. In other words, it is a measure of how much of an incident wave is reflected back to the transmitter, as far as a radar unit is concerned. This does not correlate perfectly with optical size, because of the different wavelengths involved. Light has a wavelength around the low hundreds of nm, while a radar wave on 10 GHz has a wavelength in cm.

The operator is told that the unit picks out the nearest vehicle. This is not strictly true; it picks the strongest input signal, which is quite possibly, but not necessarily, the nearest vehicle. (See Figure 2).

A container truck 'looks' to the radar some thousands of times larger than a small car, which may also be much smaller than another car of similar optical size (refer to Table 1) — wedge-shaped cars, like Porsches and Mazda sports, are 'smaller' than squarer vehicles of the same optical size. Thus a truck may have a radar return equivalent to that of a Mazda RX-7 where the truck is some *ten times* further from the radar than the Mazda. (We now see that we are dealing with a *large* dynamic range as the radar cross-sections, before accounting for distance, may vary by some 13 500 times, as can be seen in Table 1.).

The cross-section of most cars varies dependent upon the angle from which they are viewed. The return from a Honda Civic is markedly lower at 30° to the straight-on axis, so another 2 to 10 dB of variation may be introduced by different viewing angles of targets in different lanes, etc.

It is most unreasonable to expect a person to be able to say with certainty that a particular car is responsible for a particular reading. Another vehicle, up to a kilometre away, could indeed be responsible for the signal captured. In certain rare circumstances a train or aeroplane could provide the signal measured. An ex-highway patrolman writing in a recent popular American magazine claimed that the technique of situating the radar where it was likely to read an aeroplane was known in police circles as the 'final approach technique'. This all adds up to the fact that the unit cannot be regarded as infallible, as it so often is. This method of failure is by far the most likely.

Another method by which an incorrect reading can be obtained is by importunate logical interference. By this I mean some form of interference particularly directed toward the frequencies used. The units used in NSW at least are well protected from random interference, but cannot tell whether a signal returned is a reflection of their own carrier, or a foreign signal. Such a signal can be provided by a few sources, but the favourite in my opinion has to be the 'Super Snooper'. This is a very clever radar detector. Unlike most units it has a local oscillator (on both X and K-bands) and suffers from spill. This is the effect whereby some of the local oscillator signal escapes back out of the receiving antenna; almost 1 mW was measured from one unit examined, which seems typical and is due to imperfections in design and manufacture of the horn and cavity castings. Thus while it is the best detector to date, it can set off a radar trap as well. Owners of these units may have noticed that they can perceive others of their kind in cars travelling in the other direction. This is due to one unit's detecting the transmissions of the other. The frequencies involved are close, and the metal of the casting has such a temperature coefficient of expansion as to sweep the frequency of the oscillator all over the band with the temperatures likely to be encountered on a car dashboard. This kind of failure is likely to be rare, but it has been observed on more than one occasion by the author.

Other radar systems such as intruder detection systems may also be able to produce reliable readings on a radar trap, but these have not been investigated as it is assumed that the continuous indication on the display even in the absence of cars would prevent any honest operator from taking any action on the basis of it. It is the convenience of the Super Snooper type that appeals so much. (They travel in cars and so will come into interference range, up to a few hundred feet, at the same time as an unsuspecting car! They also have horns pointed directly where the trap is likely to be, of course.) Estimating the frequency of occurrence of such a failure as this is very difficult indeed, but the author thinks that maybe 1% of the Snoopers could do this, with credible, illegal readings resulting.
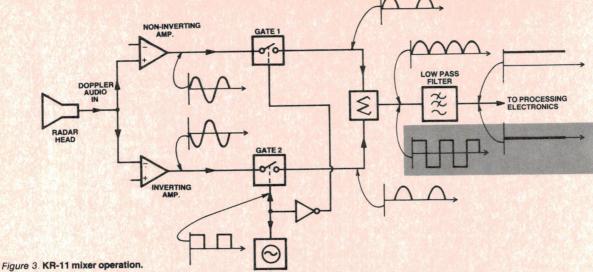
A further type of error, rather less frequently mentioned because of its rarity, or rather the rarity of the situation which promotes it, results from the very mixing function used to derive the audio tone. By its nature, the mixer outputs the sum and difference of all input frequencies. It is possible that one of the components of the output signal from the mixer will correspond to the difference between not the carrier and the signal returned from a particular target, but the difference between two reflected returns. This of course will be the sum of the relative ground speeds of the two vehicles if they are travelling in opposite directions, because, while the audio is the same for a target receding or approaching, the actual return signal frequency will be lower than the carrier sent if the car is travelling away and vice versa if it is approaching. In the case of the Digidar this is a negligible problem; it is possible that a unit employing some form of PLL could lock onto such a component, however, and give a good-looking reading when the result is in fact very false.

Police Magazine (September 1979) describes the almost instinctive ability some officers have for sensing a good reading, and for identifying the target responsible, and also does a most acceptable job of describing what the instinct is doing in concrete terms. In this identification the officer is providing the filtering function to detect and eliminate the errors that creep past the machine's own systems. It seems to be best described as the assembly and recognition of a 'good' tracking history of the target vehicle. In other words, the officer must not leave the radar unit just to emit a clear tone and display a speed, but should correlate this with a vehicle in his vision range. In an example of this the article describes an officer claiming that a truck was the vehicle corresponding to a particular return; a motor bike pulled away from behind it, but this did not affect the radar unit's response — clearly the motorbike was not the vehicle. In another situation, the same officer could say that cars which had been visible even before a truck was, and while a reading was plain and steady on the display, were not responsible for the reading. How exactly he could tell is not certain — something about the tone and the positions of vehicles perhaps — but he was proved to be correct when a large truck came over a rise and the reading continued until the cars had passed. This ability, presumably acquired by both a good perceptive wit and years of experience, cannot be quickly taught. In other words the filtering function provided by the operator is not reliable, not reproducible, and even if an operator has it, he is only human, and can be expected to relax it especially after a few hours on the job. It is therefore necessary, if we are to have readings with a confidence level adequate to take them into a courtroom, to ensure that the radar unit itself can cope, and needs no officer's attention to eliminate false or misleading readings.

Our main concern is to deal with the second mode of failure discussed above, that of the difficulty of reliably determining the source of a particular return, since it will be the most common ▶

Figure 3. **KR-11 mixer operation.**

by far. Before proceeding to discuss the legal difficulties involved here, let us look at the KR-11 type units which the NSW police are adopting.

KR-11 radar units

These units are of relatively recent design and incorporate a micro-processor. They are K-band units, which is to say that they work at around double the frequency of the Digidars, and employ circular horn antennas, similar oscillator-mixer functions, etc, to the common radar modules available off the shelf at around 24 GHz. They have provision for 'mobile operation', which is a mode where they use a ground return signal to determine the patrol car's speed and subtract this from the target's apparent speed, but we will ignore this function here as the NSW Police, who are much more careful than elsewhere, have not OK'ed the use of this mode as yet.

The KR-11 basically deals with the doppler audio signal in an analog fashion and then feeds the results to the micro, so it is the audio frequency analog section which will determine the limiting capability of the units. The signal is analysed in the frequency domain rather than the time domain, which is a good step forward.

The incoming audio is inverted by an op-amp, and the signal and its inverse are then made available to the next processing step. Either the inverse or the original may be fed to another ampli-fier; exactly which one is switched to the next amp stage is determined by two CMOS switch gates. These are alternately on and off, at a frequency determined by an oscillator. This oscillator is swept in frequency through the range of frequencies for which it is desired to search the incoming signal. When the sweeping chopper frequency equals the frequency of a component of the incoming signal, dc will appear at

the output of the amplifier which follows the two switches, amplitude roughly proportional to the strength of the return at that frequency (see Figure 3). Thus a Fourier transform or spectrum analysis is obtained.

The microprocessor controls this whole sequence. When it finds a return whose strength exceeds that preset by the operator, it stops the scan and records the frequency, and hence can determine the speed of the target. Since it searches down in frequency, it will always pick the fastest target whose return is strong enough to satisfy the sensitivity conditions. The long and the short of it all is that the KR-11 picks not the strongest ('nearest') return but that corresponding to the fastest vehicle. Like the Digidar it has 'thrown away' some information, but the hope is that it has retained a more useful piece of in-formation. For reliable operation the onus is on the policeman to pick out which car is the fastest, which may present difficulties when it is recalled that the difference in distance between vehicles returning signals just strong enough to activate the device may be a factor of around ten.

The NSW Police admit that the unit must be used with care, and plan to ensure that the officer will only take action if he can identify clearly the fast car. However, I doubt my own ability to guarantee that I could pick that with the immense range variations involved. The units have seen very little service here so far, so it is really too early to comment.

One important compliment to the efficiency and effectiveness of the NSW Police should be paid here. Operators go through a two-week course to teach them how to use the radar units correctly; in addition a great deal of effort is made to ensure that the units used by NSW Highway Patrols are both the best designs available at the time of
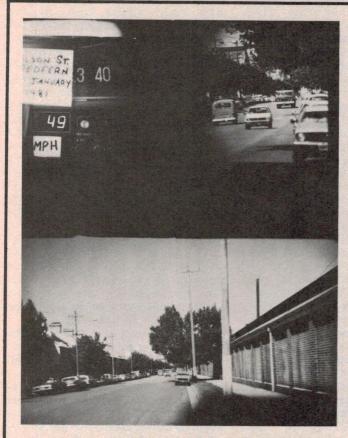
purchase and that they are kept in good running order. Regular operational checks are carefully included in the operating procedures. While it is the opinion of this author that these are not sufficient to completely remove the possibility of error, they are consider-ably more than the measures afforded by other places.
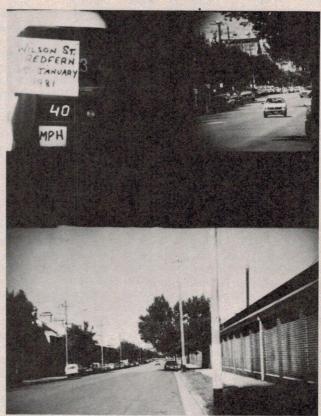
In the US some states spend a whole forty minutes teaching the policemen how to use the unit, and this is just plain inadequate, as any policeman who has gone through the NSW course will tell you. Again in the opinion of this writer, the units in Queensland are purchased and used with rather too little regard for the technicalities involved.

Two weeks is much better than forty minutes, but it is still inadequate to give a person a feel for the habits of microwaves, and this is essential for an understanding of why the units do not have a 'range' measurable in metres, and other such concepts necessary to perceiving the limitations of the radar unit as an overall idea.

Legal repercussions

So why if they can make mistakes have they not been perceived by the courts to be as fallible as this, and their use as a conclusive proof of speeding stopped? Indeed, this is the big question. The problem begins with the fact that the person who is in the position to see that the unit has malfunctioned is inevitably the driver of the vehicle alleged to be speeding. He has the speedometer in the car as one measure, and the radar unit's display as the other. Regrettably the car speedometer does not hold the reading so it is purely the word of the driver as to how fast it said he was going. On the other hand the radar unit is viewed by two policemen, and holds the display if required as well. The driver has above this a vested interest in saying that he

A PROPOSED SOLUTION TO THE RADAR RELIABILITY PROBLEM

One method of ensuring the accuracy of the radar units used in NSW is based not on redesigning the radar units but of ensuring that they are used only in the one-car situation.

In order to enable the courts to confidently accept a radar reading as correct it is necessary to provide photographic evidence of the unit's readings, the time, date and place, along with a photograph of the roadway showing enough of the environs to guarantee that the car in question was responsible for the return which resulted in the violation reading.

Dr. J.G. Lucas, a Senior Lecturer at the University of Sydney, who has been involved with the recent radar matters in NSW (the Beyer case), has produced such a device to meet this requirement in order to demonstrate its practicability. It is based on an electronically triggered camera employing Polaroid colour film, which is fitted with three lenses. One is a telephoto lens of 500 mm or so trained on the car in question. This identifies the 'offending' vehicle. The second lens photographs the radar display and a sheet with the date and location on it, as well as a clock showing the time, as a record of the event. The last lens is a wide-angle type which covers the region from the radar head to the 'offending' vehicle and the scene beyond and to the sides. This allows later checking to ensure that no other moving targets are within range.

The photograph should be developed at once and viewed by the officer operating the radar and shown to the driver of the vehicle in question (having been pulled over). If the driver proceeds with the matter, the photograph can be viewed by the magistrate of the court and an expert who can comment on the situation as it was at the instant of speed checking. If at the time of the radar reading there proves to be another possible target the officer will not pursue the matter; if not he can book the motorist with confidence.

The KR-11 units which are being phased in have a camera trigger signal output available, so interfacing is simple. The films will cost in the region of $2 a piece, which is small in comparison with the fine *and* the court costs currently incurred by the Department in defending incidents in which doubts are raised.

The initial costs of the camera units should be around $3000 each, which is expensive, but dwarfed by the current revenue the radar units produce — about $5 million per annum! The unit can be used at night as well, with suitable additional equipment.

The accompanying photographs demonstrate the unit in action. Photo A shows the scene with a small white Daihatsu Charade nearest the radar unit and a Kombi van travelling the other way. In this situation the Kombi is moving at 49 mph (78 kph) while the car is travelling at 37 mph (60 kph). *The Charade would be booked incorrectly.*

In Photo B the small car is responsible for the reading of 40 mph (64 kph). No other moving vehicles are present to interfere and this is a 'good' reading. If there are either vehicles in the foreground, as shown by the wide-angle lens, or if there are vehicles in the distance (such as the green truck behind the small car in Photo A) the reading cannot be taken as a sound one and an officer would not proceed with an infringement notice.

Admittedly, the revenue produced by radar traps would fall if this system were employed, but this is the price for achieving legal surety of the operation of the units. Most drivers will curse but not complain if they are caught fairly, and this system will remove most of the existing qualms about the operation of radar speed traps.

was not speeding (the fine and the points). It is no wonder that the court chooses not to believe the driver.

Let us now, however, investigate the situation which arose recently and which was the centre of the court case so carefully followed by the media last December. A motorist was pulled over by a radar trap operator, who clocked him at 85 kph. This motorist was the first in a group of cars, and was, he claimed, travelling at only 55-58 kph. ▶

This would have been like a large number of similar incidents where there was no chance of proving the innocence of the driver, and hence the fallibility of the radar/operator, were it not for the curiosity of another motorist in the group of cars.

This second motorist had in fact a Super Snooper which had warned him of the impending danger some distance before. He was most surprised to see the first motorist and another in the group pulled over, when he knew them to be travelling well within the limit. He continued a short distance, turned, and stopped to watch the proceedings. After the first motorist left the scene of the incident, the second hailed him and reported his action. This independent witness made legal action worthwhile.

The case was very long, primarily because the story of the two constables in question was not at all in agreement with that of the other witnesses, and the views expressed by the expert witnesses for defence and prosecution were also in direct disagreement. Now in the case of witnesses disagreeing on a matter of what they saw at the time, there is no cause for surprise, especially as they were recalling an incident which occurred 18 months or more in the past. It is, however, odd that two expert witnesses should disagree on the operation of something which is logical and well able to be analysed, such as a piece of electronic equipment.

There are a number of reasons why the matter was not quickly and conclusively resolved. These are broadly concerned with the court's inability to

THE SUPER SNOOPER

This is a heterodyne microwave radar detector unit. Its design is particularly clever and sensitive, which is why it has won a name in the market as being the best detector available.

The unit employs a twin-throat horn, so as to enable it to operate on both the K and X-bands. The horn antenna divides at its base into two waveguides, one for each band. In the same assembly are two Gunn-diode oscillators. These provide local oscillator signals for the two bands; they are mixed in with the incoming signals, and the resulting difference frequencies are fed out to be amplified and processed.

The local oscillators are rather crudely connected to the mixer cavities, which permits signal to carry back out of the horn antenna from the oscillators. It is this that prevents the sale of these units in many places. The cost of adding directional coupling of the oscillators does not justify itself in terms of the gains to be had.

The electronics include five signal and two power regulating ICs, all of which are fairly common but which are connected ingeniously to give a clear, simple and reliable detector of microwave radiation at the frequencies of the police units.

handle and make reliable judgments on matters of high technology where jargon cannot be dispensed with without making statements open to misinterpretation or technically incorrect or incomplete. The court must hear witnesses, called 'expert witnesses', and take the word of one or the other if they disagree, without being able to understand the explanation forwarded by either. The court must take the word of the one who has the most acceptable qualifications and whose explanation has been the least susceptible to attack *on legal grounds*.

In the radar case here, a number of non-technical factors were heavily in the favour of the police case. Firstly, owing to what must be regarded as a mixture of bad fortune and careful legal manoeuvring, the police were not forced to surrender a Digidar for inspection by the defence on any of the occasions of the court's being in session. The defence was finally able to obtain a unit from the US, but it arrived the night before the final day of the case, which meant that the defence people had previously had to work on what they could get from earlier court case transcripts and the evidence of the prosecution expert witness. This resulted in the defence expert witness having to make assumptions which were not correct in detail. While these did not change the final result of the argument they changed the explanation of some of the mechanisms involved, and this must of course look bad to the bench, which sees not the argument, but its need of being changed. As any reader knows, there are usually any number of electronically different ways of achieving the same end. The job done by the unit, as explained by the defence expert witness, was of course consistent with or without a unit to examine, but the method put forward as to how it was done was vague and incorrect until the final day.

Secondly, the police radar expert had had a great deal of experience giving evidence in court cases, and so his manner was, quite understandably, clear and well rehearsed. This is a credit to the organisation of the prosecution and evidence that they had all done their homework, but it imparts a rather unjust bias to the situation which does not necessarily serve the ends of justice.

Thirdly, a number of statements were made regarding the radar units which were literally correct but technically misleading. These were not a result of direct attempts to mislead; rather they were statements 'watered down' to make them comprehensible to a court. These relatively unimportant matters were hounded by the counsels, each searching for a means of casting doubt

on the technical abilities of the other side's expert witness. Such activities may be legally rewarding, but do not serve the purpose of exposing the truth.

Another problem arises when the background of the two expert witnesses is taken into account. The police expert witness has had a long career in the radar field, but has learnt his facts from the use and maintenance of many radar units. This gives him a very sound knowledge of what is visible, but not necessarily of the theories used to design the units in the first place, nor of any theories which might only be seen as relevant with the current questioning of the unit's infallibility. On the other hand, the defence expert has a sound university basis in engineering, but is relatively newly concerned with doppler radar and its application to traffic on the ground. Their arguments thus understandably stemmed from different viewpoints, and were hard for non-technical minds to reconcile.

It is informative to note that the police radar unit trains its own technicians and experts from the ranks. This approach, the police correctly claim, ensures that only men likely to remain with the unit for a considerable time are employed there, but it means that they do not usually hire people who are broadly educated in the technical side of engineering in general. An example of the limitation imposed by this is the test setup employed at Flemington for checking radar units. It consists in part of an HP9845 desktop computer controlling a number of buss-compatible instruments, such as programmable frequency generators, etc. The software for these is purchased from HP as part of the purchase contract on all the buss-compatible gear. This is simpler than training a police technician in the art of computer programming.

The problem of broad vs. narrow education in the course case served only to cloud the issue, forcing the court to rely more on the reputation of the witnesses than their arguments' validity. It was beyond the ability of the defence to bring further expert witnesses to give evidence (the lawyer's and other witnesses' time was given gratis) and so the current case finished in favour of the defendant, but without clear resolve being obtained on the technical aspects. With information such as this article now gives made public, further attempts to reach a conclusive result based on validity of argument rather than credibility of arguers should become possible. It is in this hope that this is written, as well as making the technically wise reader aware of the beast with which he is dealing, so that he can better handle it. ●

Galileo modified

The American National Aeronautics and Space Administration's plans for the Galileo mission to explore the environs and atmosphere of Jupiter, as described by Brian Dance (ETI October 1980), have had to undergo radical changes.

Andrew Rennie

New Zealand Spaceflight Association

PLANNED TO BE a dual orbiter and probe spacecraft launched by a single Space Shuttle Orbiter with a two-stage inertial upper stage, the mission was in obvious trouble by early 1979 as it became increasingly apparent that the shuttle was not going to meet its 1979 launch schedule. As more and more troubles plagued the shuttle programme, the first launch date progressively slipped back towards 1981, forcing a corresponding drift by Galileo up the shuttle payload manifest. In mid-1979 it was pencilled in for the third operational mission, set for launch in January 1982.

Meanwhile, as Galileo progressed from a gleam-in-the-eye of the Jet Propulsion Laboratory project scientists through to the definite hardware plans of the engineers, its mass increased. Unfortunately for Galileo, a similar mass increase was occurring in the inertial upper stage development programme.
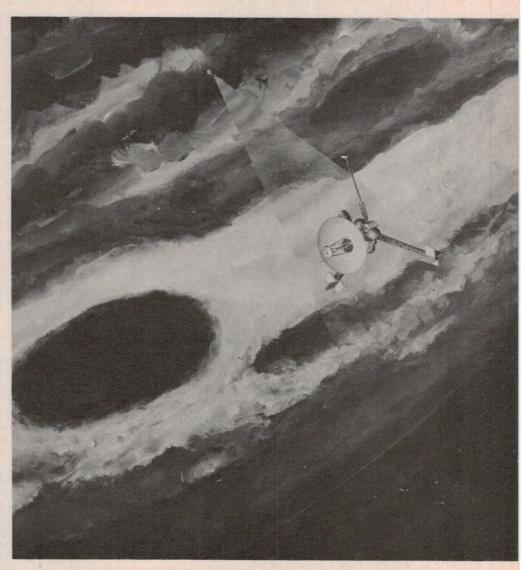
By June 1979 a situation where the two vehicles were too heavy to be acceptable had been reached. Galileo could not be trimmed below its basic maximum planned mass of 2015 kg, and the space shuttle performance could not be increased. As it was, the (by 1982) largely untried shuttle would have to be flown with some critical modifications. These included use of a lightweight external tank, use of the main engines at 109% of normal rated thrust, and the removal of all non-essential hardware from the shuttle orbiter.

This left the inertial upper stage as the only area where mass reductions were possible. Engineers, poring over their plans, reduced the 'paper' mass of the stage to the desired level. This left a margin of only 50 kg, which was considered too narrow.
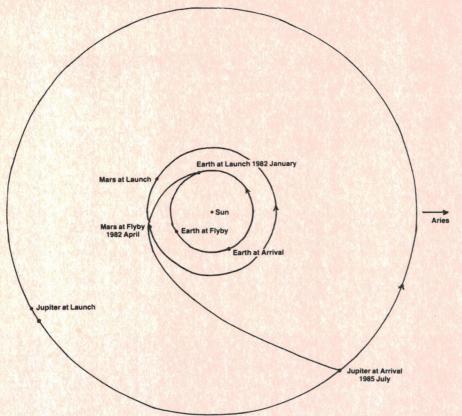
During the remainder of the 1979 American summer, mission planners continued to re-examine how the Galileo mission would be conducted.

By September 1979 it was clear, even to those whose knowledge of the project was confined to reading NASA's 'rose-tinted' press releases, that there was no possibility of launching Galileo in 1982. Two major options presented themselves.
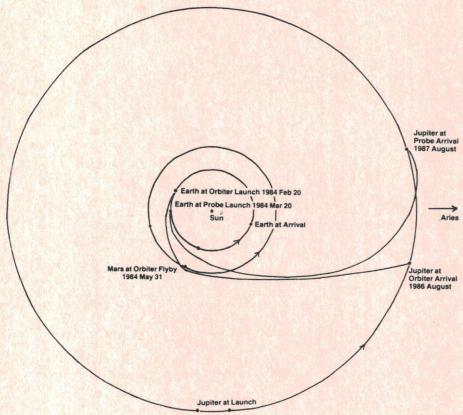
The first was to modify the shuttle to allow it to carry the cryogenic Centaur stage (familiar as an upper stage on the Atlas Centaur and the Titan 3E Centaur expendable launchers). However, this option would have required a panic effort to prepare the Centaur by January 1982. NASA therefore declined that option, leaving project personnel ruefully wishing they had chosen the higher energy Centaur at the inception of Galileo.

The Galileo mission will launch a probe that will descend into Jupiter's atmosphere

Earth at Launch 1982 January

Mars at Launch

· Sun

Mars at Flyby
1982 April

Earth at Flyby

Earth at Arrival

Aries →

Jupiter at Launch

Jupiter at Arrival
1985 July

TRAJECTORY OF CANCELLED 1982 GALILEO MISSION

Jupiter at
Probe Arrival
1987 August

Earth at Orbiter Launch 1984 Feb 20
Earth at Probe Launch 1984 Mar 20
Sun
Earth at Arrival

Aries →

Mars at Orbiter Flyby
1984 May 31

Jupiter at
Orbiter Arrival
1986 August

Jupiter at Launch

TRAJECTORY OF PLANNED 1984 GALILEO MISSION

This left the second option, of delaying the mission to the 1984 launch 'window'. However, the energy requirements for this 'window' are even greater than for that of 1982. There was thus no choice. The mission had to be split, with the orbiter and probe being launched on separate shuttle flights.

Plans were thus drawn up to launch the Galileo orbiter using a shuttle and two-stage inertial upper stage on February 20, 1984, followed by the Galileo probe on March 20, 1984. The delay and splitting would add $225 million to overall mission costs; NASA went cap-in-hand to Congress for the extra funds.

The new Galileo orbiter trajectory, as currently planned, still takes advantage of a gravity assist at Mars. The position of Mars during the new mission's flyby is not as advantageous as the 1982 trajectory, and the difference in the planet's position requires that a major spacecraft propulsion burn be made during the 1984 Mars pass. The craft would therefore have to carry extra propellant (1400 kg instead of 850 kg) to effect the necessary 1000 m/s velocity change.

It was decided that an extra Mars propulsion module would be required. A German company has been awarded the contract to supply the engine, which will be jettisoned after the Mars flyby — the first time that staging has occurred in deep space (discounting the separation of the Viking orbiters and landers in 1976).

Flight time for the combined 1982 orbiter/probe was to have been approximately 3½ years. The new plans call for a 2½-year flight for the orbiter and 3½ for the probe. The probe takes longer because it will not use the Mars gravity assist, but will instead fly directly out beyond the orbit of Jupiter before looping back down on the target.
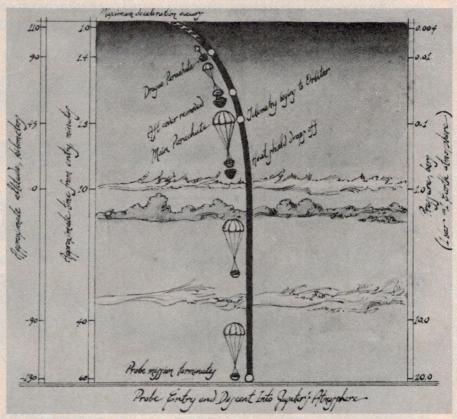
Splitting the mission means that the orbiter will no longer need the mating attachments for the probe, but will have extra requirements for the powered Mars flyby. A new spacecraft to carry the probe is also required. It was not immediately decided whether this would be a completely new design, or a modified existing spacecraft design, and requests for proposals were issued to industry.

Two major responses were submitted. McDonnell-Douglas proposed to use a modified International Solar Polar spacecraft. This mission would send two craft, one American and the other European, out to Jupiter, whose gravity would whip them back over the North and South Poles of the Sun. The European craft would carry the Galileo probe.

The proposal by Hughes Aircraft Company was for a new design. In November 1980, Hughes was selected to develop its $40 million probe carrier.

The Jupiter arrival strategy has had to be changed to meet the new mission design. The probe's descent data was originally to have been relayed to Earth by the orbiter. In the new plan, the orbiter will not be suitably placed in its Jovian orbit to perform this function. Consequently, the probe carrier will have to be able to perform the relay, permitting the removal of the relay electronics and antennae from the orbiter. The probe carrier features a fixed parabolic dish antenna parallel with its spin axis to receive probe data. This data will then be sent back to Earth using a despun antenna.

Although target entry point at Jupiter for the probe remains within 5° of the equator, the release time for the carrier was not immediately decided by the mission planners. It will be between 50 and 150 days before the 1987 July entry — most probably 100 days. As in the original plan, following probe release the carrier will be deflected to miss Jupiter impact. Unlike the orbiter, the carrier will not be fired into Jovian orbit, but will flyby Jupiter and continue through the Solar System. ●

An artist's impression of the Probe's descent into the Jovian atmosphere showing the heat shield being jettisoned and the parachute opening.

Series 5000 MOSFET stereo amp

This is it! A 100W/channel stereo power amplifier featuring 0.001% distortion.

David Tilbrook

IN LAST MONTH'S ISSUE we gave details for the construction of a stereo power amp module suitable for mounting to the ETI front panel heatsink. All that remains to complete construction of the 100 W/channel Series 5000 power amplifier is to assemble the chassis, build in a power supply and see to the earthing details.

Housing the Series 5000 Stereo Power Amplifier presented a few headaches. Heatsinking presented the biggest headache. Barry Wilkinson, once ETI's project manager, has a saying: "If you can't hide it, make a feature of it"! So we did. We designed a heatsink/front panel. It consists of a special aluminium casting, designed to conform to one of the standard 19-inch (430 mm) panel sizes. A chassis assembly is readily attached to the rear, consisting in this case of four 10 mm square-section aluminium bars, each about 230 mm long, supporting the rear panel.

Construction is clear from the photographs. A U-section aluminium top plate plus a flat bottom plate completes the case. Attach feet and you have a stand-alone unit.

The ETI heatsink/front panel will be available from kit and component suppliers as well as directly from us, via mail order. (See the end of this article.) We have designed it to be a 'universal' component and intend to use it in other projects in the future.

The power supply shown last month is suitable for a single ETI-477 module. Two of these could be used as independent supplies in the stereo amplifier but in the final assembly we have elected to use two power transformers to form a single, higher current power supply. The advantage normally associated with independent power supplies is the reduction of crosstalk between channels. In the case of the ETI-477 module however, the high supply rejection of the design reduces crosstalk to a level that is completely insignificant (i.e: around the noise level), so independent supplies offer no real advantage. On the other hand the use of two PF4361/1 power transformers in a single power supply yields a supply capable of more than 100 V at over 7 A continuous. On page 32 is the circuit diagram for the Series 5000 power amplifier. The Ferguson transformer specified has two, independent 35 V windings. These are connected in parallel to produce a single 35 V RMS winding capable of supplying 5 A RMS.

The two transformers then have these secondaries connected in series to provide the centre-tapped supply. When paralleling the windings of a transformer it is essential that they are connected together in the correct way. In the Ferguson transformer the start of the two windings are the black and red wires which should be connected together to form one terminal connection. The finish of the windings are the orange and yellow wires. These are connected together to form the other terminal. If the windings are connected in any other way the power transformer will be damaged when switched on.

One terminal of each transformer is connected to the bridge rectifier, a 35 A type. The filtering for the power supply is done with two 8000 µF capacitors to form a total of 16 000 µF across each half of the dc supply rails. The resulting dc supply voltage should be approximately ±52 V, unloaded. At full power this will drop to around ±50 V. With a 10 V drop across the output devices the peak signal voltage before clipping is around 40 V, which gives 100 W into an eight ohm load. In reality, the voltage drop across the MOSFETs is not as high as this since the ETI-477 module uses two devices in parallel. The maximum output power of the prototype unit using the power supply shown was 112 W single channel and 105 W both channels driven.
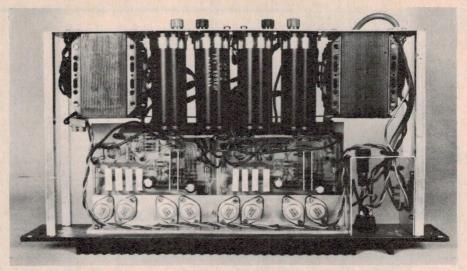
By far the biggest problem in the design and construction of any amplifier is that of earthing. If maximum performance is to be obtained from the ETI-477 modules great care must be taken to ensure complete isolation of high current earths from low current ones such as the input signal earth. If this is not done the large currents flowing in the speaker return earths, for example, will interact with the input and distortion results. Similarly, if the earth current from the electrolytic capacitors is allowed to interact with any low current signal earth the amplifier will have degraded hum figures and may even be unstable. The pc board layout has been designed to overcome these problems through the use of a *single-point* earthing arrangement. Earth lines from the output devices and power earth lines from the on-board electrolytic capacitors are kept separate until they reach the 0 V point on the circuit board.

The main input signal earth is the most critical.

The power amplifier will regard as a valid input any voltage difference between the input and the input earth terminals. So any hum present on this earth will be treated as an input and amplified accordingly. In order for the hum level to be inaudible from a 100 W power amplifier it must be at least 90 dB below the full output voltage, which is around 0.9 mV. Since the voltage gain of the ETI-477 is approximately 23, the equivalent input signal voltage is 0.9 mV/23 ≑ 39 uV! It is clear that even a *minute* hum level at the input will produce an audible hum at the output. To overcome this problem the input earth is isolated from the 0 V track on the circuit board by the 10 ohm resistor R3, shown on the ETI-477 circuit diagram in last month's issue. The input wiring to the module is done with a twisted pair of 10 amp hookup cable and the connection for the input earth is done at the input RCA sockets. This is shown in the circuit diagram for the Series 5000 amp assembly and in the wiring diagram on page 32. The 10 amp hookup cable is used instead of the more usual shielded cable, since in this application the lower resistance of the hookup cable results in better hum rejection.

The remaining earth problem is the possibility of hum loops caused by the fact that both the power amplifier and the preamplifier used to drive it must be connected to the same chassis ground point via their power cables. If the chassis of both the preamp and the power amp are connected to the 0 V point on their respective power supplies and the two 0 V points are connected together via the shielded cables between the preamp and power amp, a closed circuit is formed. Any hum currents induced into the earth lead of the three-core power cable, for example, can flow through the chassis of the power amp to the power amp 0 V point, down the shielded cable at the power amp input, to the 0 V point in the preamp and via the preamp chassis around the loop again. The presence of this hum current in the power amp input earth will be seen as an input by the power amp and output hum results. The cure is to open-circuit this loop so that hum current cannot flow in the input signal earth line. The best way to do this is to break the connection between the chassis of the power amp and the 0 V point on the power supply. In this way the power amp still has a valid earth reference at its input but the possibility of a hum loop is eliminated.

The disadvantage of this technique is that the chassis can no longer act as an effective shield to external electrical noise sources, but this problem can be

Internal view of the amplifier showing general construction. Note the twisted lead running from the transformer at left, around the front panel, to the 'mains termination box' at front right. The two transformers are mounted using brass washers between the panel and their mounting brackets.

overcome by capacitively coupling the chassis to the 0 V track at selected places in the power amplifier. The relatively high impedance of these capacitors at 50 Hz still maintains an effective open circuit to prevent the hum loop problem.

The earthing procedure outlined above has consistently given good results both in the prototype Series 5000 amp and in numerous other power amps, and provides the power amplifier with good earthing that is not affected excessively by the earthing configuration used in the preamp.

Construction

If you are using the ETI front panel heatsink it can be drilled at this stage according to the details shown on the front panel drilling diagram. This diagram assumes that the single double-length heatsink bracket is used (see last month's issue). The pc board assemblies can now be mounted to the front panel using 6 BA nuts and bolts. The heads of the 6 BA bolts should fit snugly between the heatsink fins. It is essential that there is good thermal contact between the heatsink bracket and the heatsink and for this reason the entire mating surface of the heatsink bracket should be coated in heatsink paste before bolting to the heatsink.

When you come to drilling the holes for the rack mounting bolts you'll notice dimples in the front of the casting indicating the hole centres. It would be preferable to use a drill press when drilling these holes as the rack standard leaves little room for error. If drilling by hand, drill a small pilot hole first.
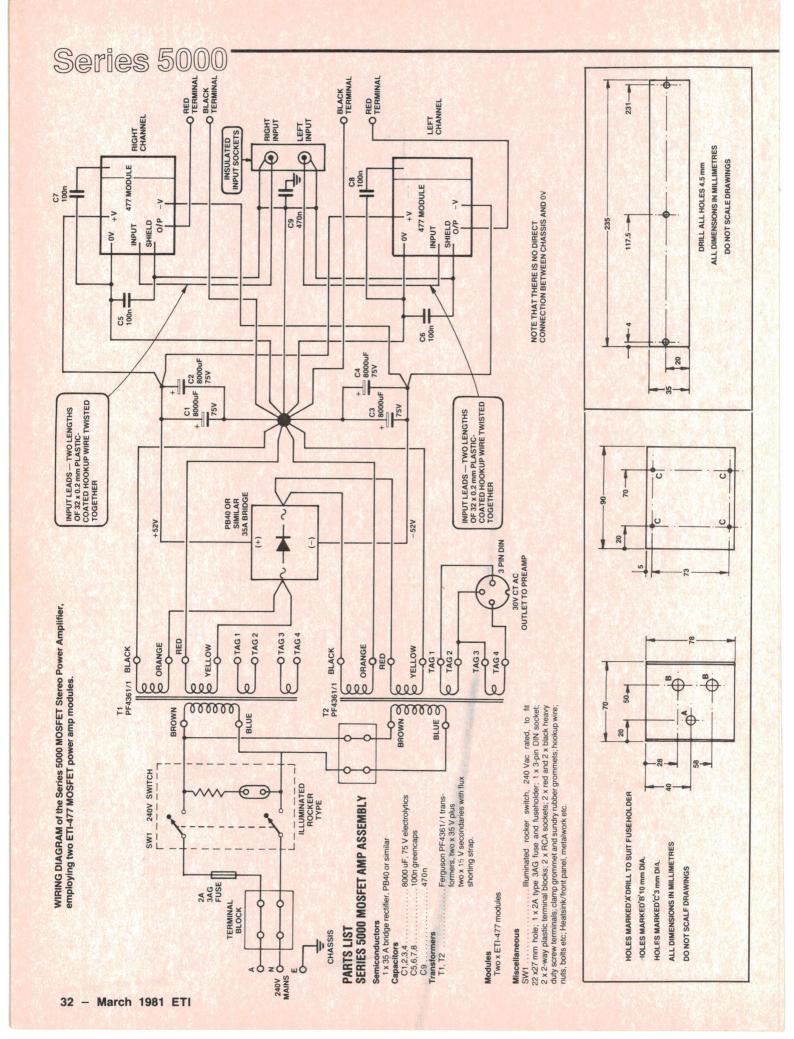
The input wires to each module should be attached at this stage. We used a twisted pair of 32 x 0.2 mm plastic-coated hookup wire. This is superior to standard shielded cable for
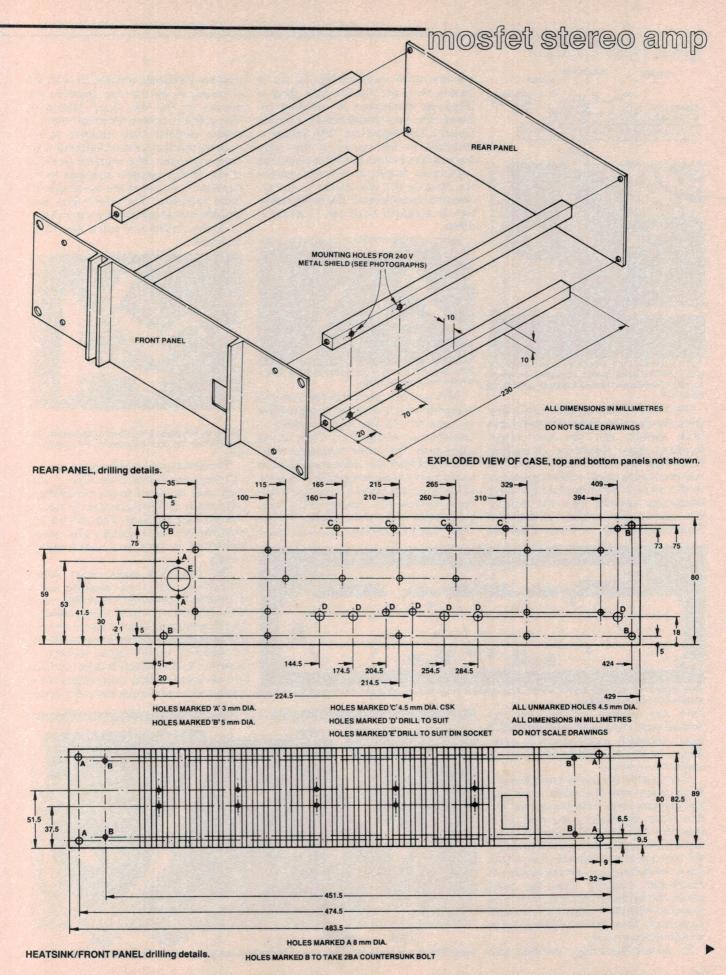
this application. The input wiring must be kept away from the 240 V wiring at the rear of the power switch. To achieve this the input wiring to both modules is taken to the left hand side of the amp, passing beside the left hand power transformer and then going to the input (see accompanying photographs).

The input leads to the left module should be around 250 mm long while those for the right channel module should be around 400 mm. This allows for trimming in the final assembly. The input 'earth' on each board has to be ac-coupled to the 0 V line on each board for the reasons discussed earlier. This is done by soldering a 100n greencap on the rear of each pc board, immediately beneath R3. The 'earthing bolt', which makes connection to the heatsink bracket, is assembled with a transistor mounting insulator on the underside of the pc board so that the bolt is insulated from the 0 V line on the pc board. A solder lug is placed under the nut. A 100n greencap is then soldered between this lug and the 0 V track adjacent. The accompanying photograph and drawing make this clear. ▶

The 0 V track on each module pc board is 'earthed' via a 100n greencap to the earthing bolt, which is first insulated from the board using a transistor mounting insulator. (See also page 34).

Series 5000

WIRING DIAGRAM of the Series 5000 MOSFET Stereo Power Amplifier, employing two ETI-477 MOSFET power amp modules.

RED TERMINAL
BLACK TERMINAL
BLACK TERMINAL
RED TERMINAL

RIGHT CHANNEL
LEFT CHANNEL

RIGHT INPUT
LEFT INPUT

INSULATED INPUT SOCKETS

C7 100n
C8 100n

477 MODULE
477 MODULE

0V +V INPUT SHIELD O/P −V
0V +V INPUT SHIELD O/P −V

C9 470n

C5 100n
C6 100n

INPUT LEADS — TWO LENGTHS OF 32 x 0.2 mm PLASTIC-COATED HOOKUP WIRE TWISTED TOGETHER

INPUT LEADS — TWO LENGTHS OF 32 x 0.2 mm PLASTIC-COATED HOOKUP WIRE TWISTED TOGETHER

C2 8000uF 75V
C1 8000uF 75V
C4 8000uF 75V
C3 8000uF 75V

+52V
−52V

PB40 OR SIMILAR 35A BRIDGE
(+) (−)

3 PIN DIN

30V CT AC OUTLET TO PREAMP

ORANGE RED YELLOW TAG 1 TAG 2 TAG 3 TAG 4
BLACK ORANGE RED YELLOW TAG 1 TAG 2 TAG 3 TAG 4

T1 PF4361/1
T2 PF4361/1

BROWN BLUE
BROWN BLUE

ILLUMINATED ROCKER TYPE

SW1 240V SWITCH

2A 3AG FUSE

TERMINAL BLOCK

A N E
240V MAINS
CHASSIS

PARTS LIST
SERIES 5000 MOSFET AMP ASSEMBLY

Semiconductors
1 x 35 A bridge rectifier, PB40 or similar

Capacitors
C1,2,3,4 .... 8000 uF, 75 V electrolytics
C5,6,7,8 .... 100n greencaps
C9 .... 470n

Transformers
T1, T2 .... Ferguson PF4361/1 transformers, two x 35 V plus two x 15 V secondaries with flux shorting strap.

Modules
Two x ETI-477 modules

Miscellaneous
SW1 .... Illuminated rocker switch, 240 Vac rated, to fit 22 x27 mm hole; 1 x 2A type 3AG fuse and fuseholder; 1 x 3-pin DIN socket; 2 x 2-way plastic terminal blocks; 2 x RCA sockets; 2 x red and 2 x black heavy duty screw terminals; clamp grommet and sundry rubber grommets; hookup wire; nuts, bolts etc; Heatsink/front panel, metalwork etc.

NOTE THAT THERE IS NO DIRECT CONNECTION BETWEEN CHASSIS AND 0V

231
235
117.5
4
20
35

DRILL ALL HOLES 4.5 mm
ALL DIMENSIONS IN MILLIMETRES
DO NOT SCALE DRAWINGS

90
70
20
5
73
C C C C

78
70
50
20
28
58
40
B B A

HOLES MARKED 'A' DRILL TO SUIT FUSEHOLDER
HOLES MARKED 'B' 10 mm DIA.
HOLES MARKED 'C' 3 mm DIA.
ALL DIMENSIONS IN MILLIMETRES
DO NOT SCALE DRAWINGS

REAR PANEL

MOUNTING HOLES FOR 240 V
METAL SHIELD (SEE PHOTOGRAPHS)

FRONT PANEL

10

10

230

70

20

ALL DIMENSIONS IN MILLIMETRES

DO NOT SCALE DRAWINGS

REAR PANEL, drilling details.

EXPLODED VIEW OF CASE, top and bottom panels not shown.

35
115
165
215
265
329
409

5
100
160
210
260
310
394

75
B
C
C
C
C
B
73 75

80

A
E

59
53
41.5
A

30
21
D
D
D
D
D
D
D

5
B
B
18

5

5
144.5
174.5
204.5
254.5
284.5
424

20
214.5
429

224.5

HOLES MARKED 'A' 3 mm DIA.   HOLES MARKED 'C' 4.5 mm DIA. CSK   ALL UNMARKED HOLES 4.5 mm DIA.

HOLES MARKED 'B' 5 mm DIA.   HOLES MARKED 'D' DRILL TO SUIT   ALL DIMENSIONS IN MILLIMETRES

HOLES MARKED 'E' DRILL TO SUIT DIN SOCKET   DO NOT SCALE DRAWINGS

A
B
B
A

80 82.5 89

51.5
37.5
6.5

A
B
B
A
9.5

9

32

451.5

474.5

483.5

HOLES MARKED A 8 mm DIA.

HEATSINK/FRONT PANEL drilling details.   HOLES MARKED B TO TAKE 2BA COUNTERSUNK BOLT

0V TRACK — SOLDER LUG — 6BA NUT
100n — TRANSISTOR INSULATING BUSH
(COPPER SIDE) — PC BOARD — HEATSINK BRACKET — 6BA BOLT

TOP: 'Earthing' the 0 V track on each module (C7, C8). LOWER: Capacitors C5, C6 mount beneath R3 on each module and couple the input earth to the board 0 V.

Next step is the rear panel assembly. Once the panel is drilled, the two input RCA sockets and the four output terminal posts should be assembled. Note that the two RCA sockets are mounted using small rubber grommets in the holes so as to insulate the outer connection (shield) from the chassis. See the accompanying photograph. Grommets having a 6 mm diameter
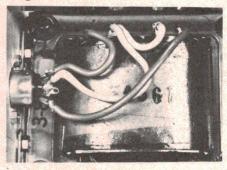
provide some heatsinking for it, a 35 mm wide by 235 mm long strip of 20 gauge aluminium is mounted between the two transformers, running beneath the capacitors. The bridge is mounted in the centre of this strip towards the bottom so that it clears the capacitors. A bolt at each end secures the strip to the end cheeks of the respective transformers. The bridge rectifier is mounted with its + terminal down.

Mounting and wiring of the bridge rectifier. The + terminal is uppermost here.

Now you can commence the wiring (a complete wiring diagram is reproduced on page 32). Do the bridge rectifier — transformer wiring first. Then do the capacitors. The lower terminals of all four capacitors are connected together using heavy braid stripped from a piece of RF type coax cable. The centre of this buss becomes the central 0 V return point (refer to the photograph). The two right hand capacitors also have their
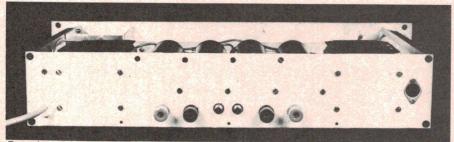
positive terminals bridged by a length of braid, as do the two negative terminals of the left hand capacitors. The positive output terminal from the bridge rectifier then connects to the positive terminal of the innermost right hand capacitor. The negative terminal of the bridge rectifier connects to the negative terminal of the innermost left hand capacitor. Two wires from each transformer secondary are wired directly to the central 0 V point (see wiring diagram).

Wiring of the preamp ac supply DIN socket. The transformer tags are numbered 1, 2, 3, 4 from the left.

The preamp ac supply output socket (oh yes, a preamp is on the way . . . Ed.) may now be wired to the transformer adjacent to it. Wiring is clearly seen in the photograph here. The two 15 Vac transformer secondaries are series connected to provide a centre-tapped supply.

The two RCA input socket shield connections are wired together and a 470n/250 V greencap capacitor wired from this connection to a panel ground lug. The latter is secured under a nut on the capacitor mounting bolt immediately adjacent to the input sockets. A separate earthing lead is then run from the common shield connections from each input socket, back to the 0 V point.
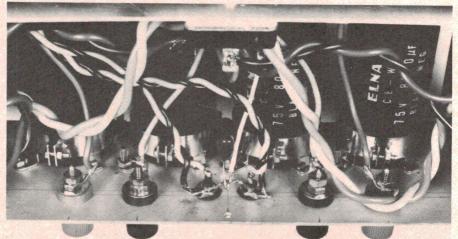
Rear view of the chassis. Note the RCA input sockets are mounted using grommets plus the preamp supply DIN socket at right.

hole are perfect for the job. Alternatively a two-way insulated RCA input terminal panel could be used. Mount the three-pin DIN socket next (ac output for preamp).

Next mount the power transformers. Place them with the solder terminals and primary leads facing *outwards*. The four filter capacitors come next. Note that the four holes for the capacitor mounting brackets along the top edge of the rear panel are countersunk so that the lip of the top panel for the case is not obstructed. Looking from the front panel, the left hand pair of capacitors is mounted with their negative terminals uppermost, the right hand pair positive terminals uppermost.

To mount the bridge rectifier, and

Input RCA socket wiring. Note which direction the twisted pair leads from these sockets are dressed.
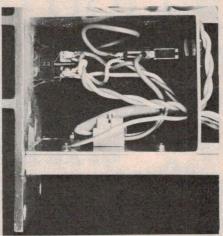
The two speaker negative terminals, mounted either side of the input RCA sockets, are individually wired to the central 0 V point next.

Incidentally, if you're worried that the + terminal of the bridge rectifier may short to the bottom panel, bend it in a little and sleeve the connection.
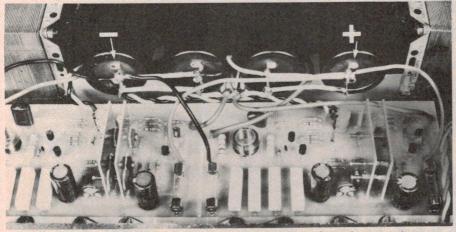
The four 10 mm square aluminium bars may now be attached to the rear panel assembly. There are two 'upper' bars and two 'lower' bars and don't forget that the bars at the right hand end are drilled to take the mains termination and fuse assembly. The front panel assembly (with the two modules mounted) can be attached now. We placed 4 BA steel washers between the front panel and the four bars to accommodate the depth of the top cover we used, but this may be unnecessary in your case.

With the chassis assembled and tightened up, the wiring may be completed. Do the power supply to module wiring first. *We recommend you use 32 x 0.2 mm plastic-coated hookup wire;* anything less will probably degrade performance. The negative rail of each board connects to the uppermost (negative) terminal of the left hand

The 'mains termination box', showing general assembly and wiring.

snap-lock mounting arrangement. There are several makes available and these fit the 22 x 27 mm hole provided in our panel. If you prefer something different an escutcheon may be fitted in this section of the panel. We noticed that the rocker switch sold by Dick Smith stores (cat. no. S-1506) has snap-lock flutes designed to hold the switch to a thinner gauge panel. You will need to trim them — carefully — to get this switch to fit our panel.

Wiring of the four filter capacitors. Note the common 0 V point between the two inner capacitors.

capacitor, while the positive rail of each board connects to the uppermost (positive) terminal of the right hand capacitor. This is visible in the photograph of this portion of the assembly. *Use separate leads; do not connect one board to the other, then to the capacitors.* The 0 V rail of each board is wired, *using separate leads,* to the central 0 V point, visible between the two innermost capacitors. Each speaker output lead is wired to its respective output terminal.

Now we come to the 240 Vac wiring. The mains switch is a DPDT illuminated rocker type that has a push-in,

A U-shaped sub-assembly is mounted behind the mains switch, secured to the adjacent bars which run between the front and rear panels. This mains cable terminates at a two-way plastic terminal block mounted on the outer side. The mains fuse holder is mounted on the rear side. Also on the rear side are two grommetted holes. The lower and larger one provides an entry for the mains cable. The mains cable itself enters the cabinet via the back panel, secured with a clamp grommet (see rear photograph). The smaller, upper hole provides passage for the mains earth lead, which returns to an earth lug on the rear

panel. The ac wiring to the transformer primaries also passes through this hole.

The active (brown) mains lead is wired to one pole of the mains switch via the fuse. The neutral (blue) is wired to the other pole of the mains switch. A twisted pair is taken from the mains switch terminals to another two-way plastic terminal block mounted on the left hand transformer. This cable is routed around the front panel, secured with cable ties held by several of the module heatsink bracket bolts. The right hand transformer is wired directly to the output terminals of the mains switch, the wires passing through the smaller grommetted hole.

That should complete the wiring. But, before proceeding to test the amplifier, *check all your wiring thoroughly.*

Getting it going

Having satisfied yourself that all is well, remove the fuses on each pc board, arm yourself with a multimeter, hold your breath . . . and switch on. Assuming no disasters occur, measure the supply rail voltages. They should be around 52 V. If you have previously set up your modules then you can replace the four fuses and proceed with listening tests. Before replacing the fuses allow sufficient time for the electrolytic capacitors to discharge. This will take several minutes.

The general set-up procedure was discussed on page 32 of the January issue.

Once you have completed the set-up procedure, your amplifier is ready for listening tests.

The top and bottom covers can be screwed in place once you've confirmed all is well. We recommend you use aluminium for these items as steel plates will react with the field of the transformers and produce quite a loud hum.

We trust you enjoy your Series 5000 Stereo Power Amplifier.

The second project in the Series 5000 range will be a high quality control preamp that is already in the prototype stage.

Performance

The objective of this project has been to design a power amplifier module of the highest possible performance. Ideally the power amp should produce an amplified version of its input signal and contribute no sound of its own. In order to design a practical amplifier that will come as close as possible to this ideal, it is necessary to 'define' limits on the input signal characteristic and then

ensure that the power amp exceeds these limits.

The problem of amplitude overload cannot be eliminated, since no practical power amplifier has access to infinite supply voltage. In order to overcome this problem, the ETI-477 module has been designed to handle in excess of ±50 V rails, giving it a conservative power rating of 100 W RMS into 8 ohms. The output stage has been designed so that the MOSFETs will not operate outside their safe operating area on any load in which the effective series resistance does not drop excessively below 8 ohms.

Similarly, since no power amp has an infinite slew rate or infinite frequency response, the input signal has been limited by a passive input filter. It can be easily demonstrated by experiment that the introduction of a passive filter that does not excessively affect the frequency response within the audio passband will not affect the sound of the input signal. This filter will define a

of the differential pair is its relatively high supply rejection, a parameter which is often not given sufficient attention in power amp design.

Careful control of the feedback loop and the use of a passive filter/load on the output of the module, coupled with the design points mentioned above, have yielded an amplifier with particularly low dynamic distortion characteristics. An amplifier that has been designed with these objectives in mind will automatically have low THD and TID figures. The ETI-477 is no exception, with a THD at 1 kHz and 10 W RMS of less than 0.001%, rising slightly to around 0.003% at 10 kHz (top end distortion figures are a function of bias current). It should be remembered, however, that obtaining low THD figures should not be the prime objective of a good power amplifier design, but results from the reduction of dynamic distortion mechanisms already discussed.

output signal earth.

The subjective performance of the 477 module has confirmed for me the validity of the basic design approach. The sound is clean with no sign of the aggressive high frequency performance common to many transistor amplifiers. There are some amplifiers that give the subjective impression of being 'oversmooth'. By this I mean that the amplifier on first listening sounds clean and unobtrusive. Further listening tests reveal, however, that these amplifiers lack detail, and complex sounds like a symphony orchestra tend to become a single mass of sound rather than being rendered as single instruments. The ETI-477 does not suffer from this problem. When connected to my system (ETI Series 4000 Four-way Loudspeaker, Nakamichi MC1000 moving coil cartridge, Linn Sondek turntable, Stax tone arm, ETI-473 MC head amp), the result is one step closer to a system that has no sound of its own. ●

QUIESCENT CURRENT SETTING

With the quiescent current of each module set at 100 mA (1 V across 10 ohm resistors inserted across the fuse holders) the heatsink temperature will rise to typically 40°C after warm up. In use it will rise perhaps a further 30° or more, depending on programme material.

If you wish the unit to operate a little cooler, the quiescent current can be set to 75 mA on each module — adjust each RV1 for 0.75 V across 10 ohm resistors inserted across the fuse holders.

This graph shows the measured distortion versus frequency for two values of quiescent current in the output stage.

The measured frequency response of the amplifier (single module). Roll-off points are defined by the input filter (low end) and output compensation network (high end).
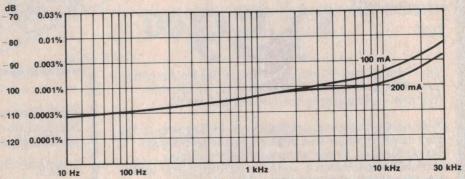
maximum possible input slope. It is therefore only necessary to design the amplifier with a slew rate that exceeds this by a sufficient margin to ensure freedom from slew-induced distortion. Since the amplifier is operated below its slew rate limit, the application of negative feedback will decrease distortion produced as a result of the signal slope approaching the slew rate (TIM).

Differential pairs have been used throughout the design to form not only the input stage but also the voltage gain stage. This ensures that the distortion characteristics of the input and voltage gain stages are low enough so that the open loop characteristics of the amplifier will be determined by the output stage. The improved frequency and phase linearity of the differential pair make it considerably easier to ensure that the amplifier meets the Nyquist stability criterion. Another advantage

The ETI-477 module has been tested exhaustively and all prototypes have performed with negligible differences.
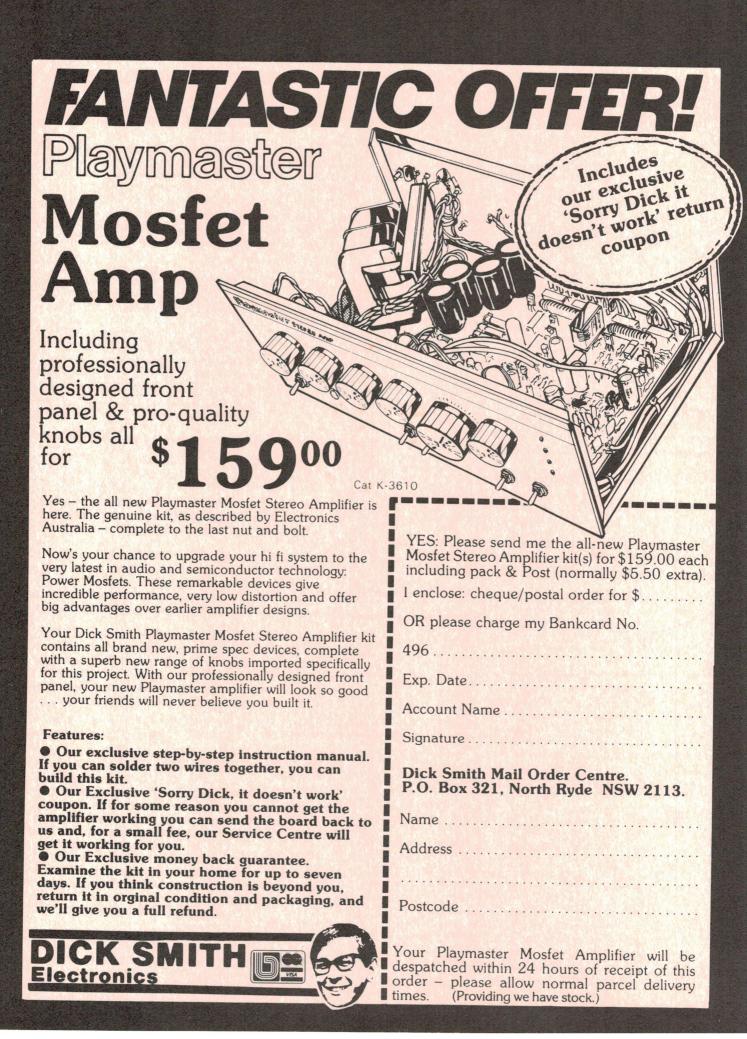
When attempting to measure distortion figures as low as these, great care must be taken with the earthing arrangement to the test equipment. The amplifier module will give its lowest distortion figures only when measured with respect to the correct earth. It may be necessary to remove the connection between mains earth and signal earth inside some distortion analysers. This problem will not arise when the amplifier is connected to a loudspeaker. This condition is not unique to the ETI-477 module, but will occur whenever an alternative earth path is provided to the

YOU'RE FANTASTIC W.A.

SPECIAL THANKS TO OUR WEST AUSTRALIAN CUSTOMERS

When we opened our first retail store in Perth on May 21st, 1979, we simply could not believe the response. Over 1000 people visited our store on that day. Some even made a special trip – just to congratulate us!

Because of your overwhelming support, which has continued over the past two years, we're opening a new store in Perth soon.

You'll find us in Cannington – just one block from the 'Carousel', at the corner of Wharf Street and Albany Highway.

There's stacks of parking, too!

Why not drop in and say hello? Watch your local papers for the opening date.

And once again, many, many thanks.

Sincerely yours,

Dick Smith

Dick Smith & staff.

AUSTRALIAN OWNED AND PROUD OF IT.
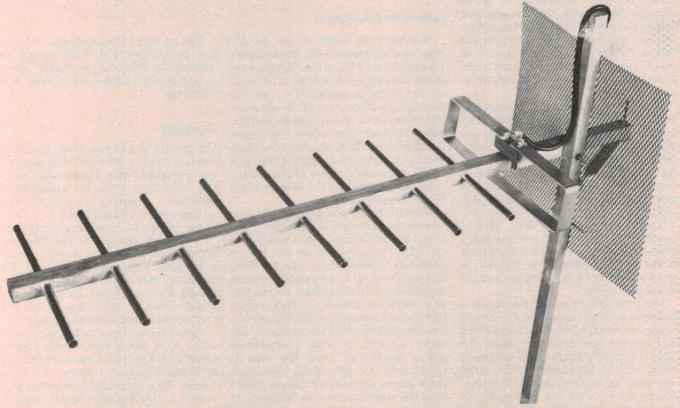
UHF TV has arrived !
— build yourself an antenna

This simple UHF antenna, from an idea provided by a reader, James Gerassimon of Penrith, NSW, proved to provide performance superior to some commercially available models.

NOW THAT 'ethnic' TV broadcasting is well under way on channel 28, and UHF repeater services for the existing VHF channels have sprung up, the time has come to exploit the advantages UHF TV offers. But first, you'll need a good antenna — assuming your TV receiver incorporates a UHF tuner! If you've bought a 'down converter' (or are thinking of doing so), then this antenna should help get you 'on the air'.

Available ready-built UHF TV antennas range in price from $20 to $100, and then there's the installation cost if you're not going to do it yourself. This antenna cost us well under $10 in material. The single most expensive item will be the coax between the antenna and TV receiver and the cost of that will entirely depend on how long a run of cable you'll need for your installation.

The design is a fairly straightforward yagi type and features simple construction, rather than optimised performance — which is nonetheless very good. James Gerassimon's original model employed 'all metal' construction, whereas we opted for a wooden boom to simplify construction yet again. General construction is obvious from the photographs.

▶

To make this antenna you'll need two metres of 10 mm dia. aluminium tube, one metre of 25 x 3 mm aluminium strip, a 300 mm square of Multimesh, one metre or more of 19 x 19 mm dressed western red cedar, plus some nuts and bolts. We bought the lot for about $7!

Project 728

Construction

James glued each of his director elements to a small square of perspex, which he then secured to his boom — consisting of a length of 19 x 19 mm aluminium box-section tubing — using glue. All his elements were made from 12 mm wide by 3 mm thick aluminium strip.

We made our antenna using a wooden boom cut from a length of 19 mm square, dressed western red cedar. The elements are 10 mm diameter aluminium tubing, the folded dipole we made from 12 mm wide by 3 mm thick aluminium strip and for the reflector we used 'Multimesh' expanded aluminium.
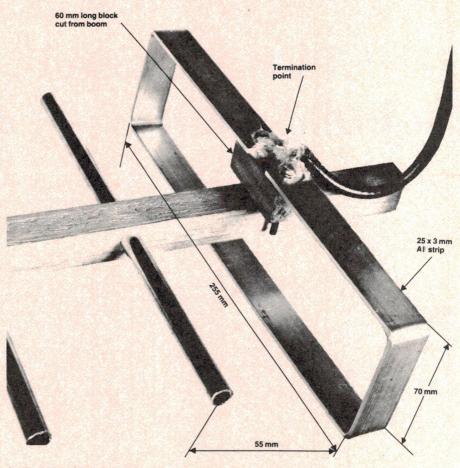
All dimensions are overprinted on the two photographs showing general construction and dipole construction.

Commence construction by cutting the boom to length. Measure the positions of all the holes and mark them clearly before drilling. The holes for the directors should be drilled using a 3/8-inch diameter drill bit. This is slightly smaller than the diameter of the directors (about 9.5 mm) and allows them to be force-fitted. When the drilling is finished, the directors can be fitted, tapping them into place with a wooden mallet or 'soft' hammer so as not to damage the tubing. So that you can centre them accurately, find the centre of each and run a mark around the tubing 10 mm either side of the centre mark. Tap the elements into place until these marks are visible either side of the boom.

The folded dipole was constructed from a 700 mm length of 12 mm by 3 mm aluminium strip. This was cut and bent to the dimensions shown in the folded dipole construction photograph. As the bandwidth of the antenna is quite broad, accuracy of measurement and cutting need not be too stringent; you've got about ±2-3 mm to play with.

The reflector consists of a 300 mm square piece of 'Multimesh' expanded aluminium, obtainable from hardware stores. This we mounted on the *rear* of the wooden mast section, as you can see in the photograph.

The termination part of the dipole is bolted to a 60 mm length of the 19 mm square cedar using two 4 BA bolts. Put a star washer and solder lug under the head of each. The boom and this block of wood should be coated before final assembly in a clear outdoor lacquer/preservative (such as 'Estapol') to protect the wood. Glue the dipole in place when everything is dry.

Construction of folded dipole.

The boom is bolted to the wooden mast section and a brace, made from a piece of the 12 x 3 mm aluminium strip, is used to support it rigidly. A 90° twist in the brace is necessary — see the photograph of the rear of the antenna. The reflector is assembled in position before the brace is attached. You'll have to cut holes in the mesh where the boom and the brace pass through it, which is easily done using a pair of sidecutters. Note that the hole for the boom is *not* in the centre of the mesh.

With the antenna assembled, the next step is to terminate the coaxial cable. Note that 300 ohm ribbon is *rarely* used on UHF installations as its loss is generally greater than coax at these frequencies and it deteriorates rather rapidly due to the weather. No attempt was made to provide a balanced-to-unbalanced connection for the coax — few commercial UHF antennas do and we've ignored it also; performance seems unaffected. Once the coax is terminated to the dipole feedpoint connections, apply a liberal amount of a suitable sealant, such as 'Silastic', to prevent water getting into the cable's insulation.
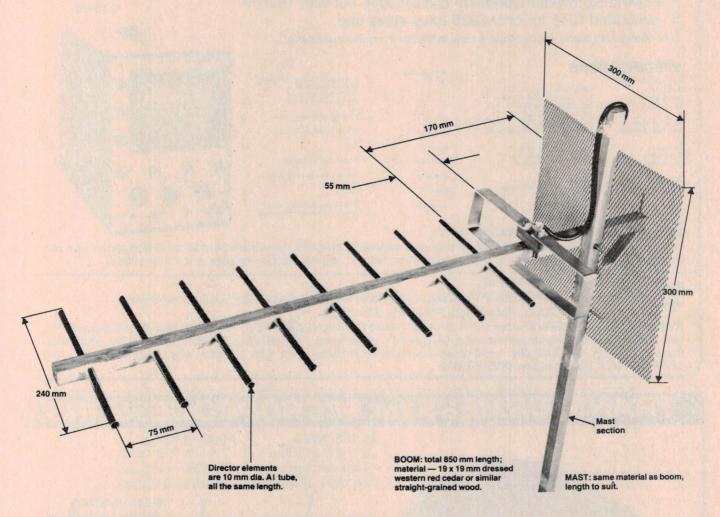
You can give the antenna a test run, but remember that UHF is not as tolerant as VHF and you should mount it pretty well where you intend it to finish up.

Results

We decided to give our antenna a *good* tryout, from a site at Annangrove, northwest of Sydney and some 55 km as the crow flies from the transmitter. 'Normal' reception without this antenna could be described as ". . . well, there might be something there, but . . ." on both channel 0 and 28. This antenna brought up a colour picture with just a smidgin of noise. No ghosting was evident. Shortly after installation, a violent summer storm passed through the area, which the antenna survived without damage.

James Gerassimon compared his antenna to a commercial model costing about $20. The latter antenna provided a weak, distorted picture, but with colour. His homemade antenna provided a considerably better picture, according to the details he supplied.

Good luck with yours! ●

300 mm

170 mm

55 mm

240 mm

75 mm

300 mm

300 mm

Mast section

Director elements are 10 mm dia. Al tube, all the same length.

BOOM: total 850 mm length; material — 19 x 19 mm dressed western red cedar or similar straight-grained wood.

MAST: same material as boom, length to suit.
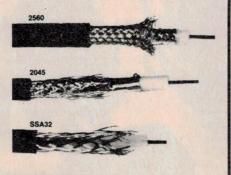
General construction. Note that a metal mast may be used instead of the wooden one.

INSTALLATION HINTS

You have to be a lot more careful when installing UHF TV antennas as UHF propagation is much more 'line of sight' than VHF. Also, UHF waves are absorbed and reflected by tiles, guttering etc. to a much greater extent than VHF.
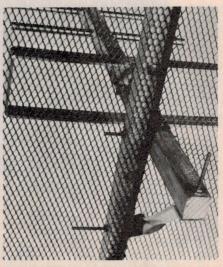
CABLE

Success will depend on the feedline chosen — choose a good quality, low loss coaxial cable from a reputable manufacturer. We don't recommend 300 ohm ribbon — neither do commercial manufacturers, it just doesn't work at UHF. Our antenna and the majority of commercial models are designed to feed 75 ohm cable. Use coaxial cables such as good quality RG59/U (from a variety of manufacturers), SSA32 (locally made by Hills) or 2045, 2560 and 2402 from Electrocraft. Those types having a foil shield and a braid over it, together with a 'foam' or 'fluted' dielectric are preferred as they will have the lowest loss and hence the best performance. Use as direct a route as possible when installing the cable to keep the cable length as short as possible, to minimise the loss.

2560

2045

SSA32

MOUNTING

Mount the antenna as high as possible and with a clear view toward the transmitter sight. Close obstructions, such as trees, other buildings etc. can adversely affect the signal so a little planning can go a long way towards getting a good result. Do not mount your UHF antenna too close to your VHF TV antenna. Separate the two by 1½ to two metres, at least, with the UHF antenna higher than the VHF antenna.

Rear view showing support strap for the rear of the boom. The picture was taken when the reflector mesh was only thumb-tacked to the mast. It has since been more securely fixed with screws.

Hold that note! — guitar sustain unit

NORMALLY, each note from a guitar has a high initial volume that rapidly decays to a much lower level, and then gradually fades out. A sustain unit provides a relatively constant output level when used with an electric guitar, despite the wide range of input levels. The most simple form of sustain unit is a clipping amplifier, but these inevitably introduce quite large amounts of distortion. A better method, and the one used in this unit, is to use a compression circuit having fast attack and decay times.

This type of circuit is basically a voltage controlled amplifier, the gain of the circuit being controlled by an output level sensing circuit which varies the gain to produce a fairly consistent output level. Little distortion is produced using this method.

In the circuit here, Q1 is used as a low noise pre-amplifier having a voltage gain of about 20 dB. Its output is fed via C3 to the input of IC1, the voltage controlled amplifier device. This has a quiescent voltage gain of about 13 dB, but this can be reduced to an attenuation of over 70 dB by taking pin 2 of the device several volts positive. Capacitor C6 couples some of the output from IC1 to the output socket, and C5 couples the remaining output to a common emitter amplifier based on Q2. The amplified signal at Q2 collector couples via C9 and R7 to a conventional voltage-doubler and smoothing (C8, R6) rectifier network. The positive bias produced by this network is fed to the control input of IC1 via a low gain amplifier and buffer stage based on IC2.
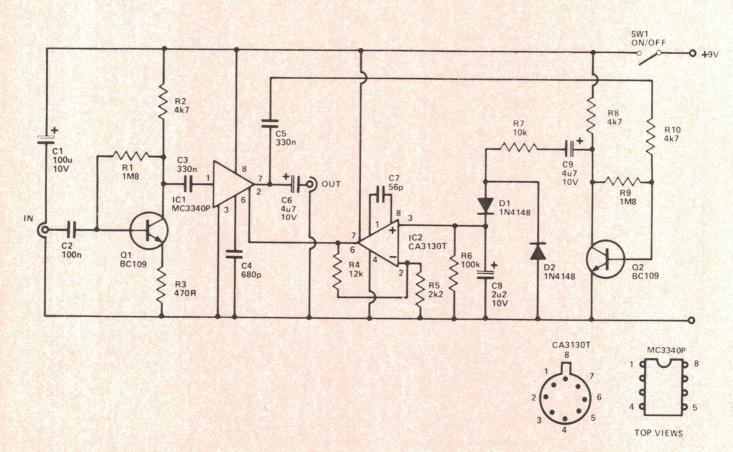
With low input levels (below about 1 mV) the control signal is too small to affect the gain of IC1. Higher level signals produce a proportionately larger control voltage and lower the gain of IC1, preventing the output level from rising much above about 30 mV RMS, and giving the required virtually constant output level.

The attack and decay times of the circuit are both quite short, so that the unit responds suitably rapidly to changes in input level, but neither of these time constants are so short as to cause serious distortion.

The unit will be most effective with the volume control on the guitar set at maximum, unless the output should then be so high as to overload the unit and cause distortion.

In constructing the unit, the usual precautions regarding hum should be taken, especially avoiding ground loops. The input and output sockets should be physically quite separate, although general layout is not too critical. Capacitor C1 is a supply bypass and is best located near IC1 with its leads having short, direct connections to pins 8 and 3 of the MC3340. ●

TOP VIEWS

JAYCAR COMES ALIVE!!

UNDER NEW MANAGEMENT

AS FROM MONDAY MARCH 2nd JAYCAR WILL BE REBORN

But who is Jaycar??

Well, for those of you who don't know, Jaycar is a well established (but not well known) supplier of EA & ETI kits as well as a broad range of electronic components. We did very little advertising.

A dedicated band of enthusiasts have patronised our one-and-only location for many years now. These people have been rewarded when they got there by finding a great range of **kits & components**. The range of components for example is **far larger** than virtually every other supplier in Australia! And at prices that make the visit worthwhile.

Specialists in Quality & Range: Our panel hardware (plugs, jacks, sockets, connectors, knobs etc) is manufactured in Japan — symbolic these days for quality electronic merchandise. In order to improve profits, some major Australian suppliers have switched to other Asian sources for this hardware. This has resulted in a noticeable drop in quality.

If you are going to spend hours and hours constructing a project you don't want the finish to be compromised by poor quality componentry. We know this and understand as we are enthusiasts too. Come to Jaycar for quality hardware — **at no extra cost.**
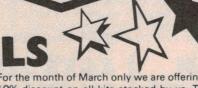
Reborn? From Monday March 2nd Jaycar will begin to go through some changes. Firstly, we will be open on the weekend for your convenience. We will be open all day Saturday and Sunday (subject to review). This will enable you to shop at your leisure without the normal city parking problems.

What else? Well you will hear more about us for a start. We will advertise more to let you know about the latest goodies we have come up with. We will also be more active in kits. On most occasions we will have a kit version of the more popular projects in both "Electronics Australia" and "Electronics Today". P.C.B.'s for most other projects will be stocked as well so that it will be likely that you will be able to make up the project from our normal broad range of components.

But that's only the start. Keep your eye on us and, **please** call in. You may find that we are a refreshing change from your present supplier — a **surprising** change in fact!

AND NOW THE NITTY GRITTY!

KIT SPECIALS

20% OFF

For the month of March only we are offering a 10% discount on all kits stocked by us. This includes: ETI480 100 Amplifiers, ETI3002 300W Amp, ETI 489 10 Band Spectrum Analyser, EA Drill Speed Controller, EA Musicolor, etc.

20% off all knobs, panel hardware, switches, etc, for the month of March only! Our normal prices are better than our major competitor's anyway — so this is a **real** saving!

MAIL ORDER CUSTOMERS:

As we are only small we don't have (unfortunately!) hundreds of mail orders arriving at our door every day. You benefit because of this, however, as we can afford to give PERSONAL SERVICE to each precious customer!
Consider:

★ SAME DAY mail order turnaround for ex-stock shipments
★ Lower prices & wider range
★ Bonus discounts for regular mail order customers
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Finally, we are NOT a company that operates from a Post Office box or has been operating for the last five minutes. We were established in 1950 — YES, 1950! — so we're here to stay a comforting thought when sending your precious money through the mail.

P&P CHARGES:
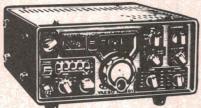
ORDER VALUE		CHARGES
$ 5	$9.99	$1.00
$ 10	$24.99	$2.00
$ 25	$49.99	$3.00
$ 50	$99.99	$4.00
$100	or more	$5.50

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GO/NO GO transistor checker

TRANSISTOR CHECKER CIRCUIT

COMPLIMENTARY OUTPUTS

NOTE:
IC1 = 4001 OR 4011
PIN 7 IS 0V
PIN 14 IS +Ve

4001 AND 4011
TOP VIEW

THIS VERY SIMPLE and inexpensive circuit is not designed to measure any transistor performance figures, but is intended for quick testing to show whether or not the test device is functional.

The basic method of testing a transistor is to first connect a supply to its emitter and collector terminals and check that no significant current flows. If the base terminal is then given a small forward bias, this will be amplified and produce a large collector-emitter current.

This circuit employs a CMOS quad 2-input NAND or NOR gate IC. Either type is suitable as each gate has its two inputs connected together so that it acts as an inverter. The first two inverters are used in conjunction with R1 and C1 as a conventional CMOS oscillator operating at a frequency of a few hundred Hertz. The other two inverters are connected in parallel and fed from the output of the oscillator so that they provide a complementary output. In other words, one output will be high and the other will be low, except during the brief periods when the outputs change state.

The collector and emitter of the transistor are fed from the outputs via LED1 and LED2, and the base is fed from one output via R2. If we assume that an NPN device is being tested, when gate 2 output is high gate 3 output is low. The transistor will be reverse biased via R2 and it should pass no significant collector current. If it is a short circuit device and does pass collector current, this will pass through LED2 which will light up and indicate the fault. When the outputs of gates 3 and 4 are in the

opposite state, the transistor will be forward biased via R2 and should conduct heavily, causing LED1 to pass a current and light up. Failure of LED1 to come on indicates an open circuit or very low gain device. PNP devices operate with the opposite polarity, and so when testing one of these it is LED2 that should switch on, and LED1 which should remain off.

The tester can be used with diodes too.

Connect one lead to C (collector connection), the other to E (emitter connection). ●

INDICATIONS
Transistors
LED1 only on .... functional NPN device
LED2 only on .... funtional PNP device
No LEDs on .... open circuit or low gain device
Both LEDs on .... short circuited device

Diodes
LED1 on .... device OK, anode lead on C
LED2 on .... device OK, anode lead on E
Both LEDs on .... short circuited device
No LEDs on .... open circuit device

---

Lab Notes

Don't go off about Schmitt triggers — look at the 4093!

This highly versatile package can be used in a wide variety of applications, including: wave-shaping, timing, logic circuits and waveform generation. Ray Marston explains.

ONE OF THE HANDIEST 'building blocks' in electronic circuitry is the Schmitt trigger — a simple circuit block whose output changes state when the input goes above or below a certain "threshold". The rising input threshold may be set at one level and the falling input threshold may be set at another level — usually below the former. The difference between the two levels is called the threshold "hysteresis".

The wonders of small-scale integration can now bring you four Schmitt triggers in a single package! What we are discussing this month is the 4093 CMOS IC.

This device is a quad two-input NAND Schmitt trigger — to use the jargon. It is a highly versatile package that can be used in a wide variety of applications, including: wave-shaping, timing, logic circuits and waveform generation.

Schmitt Applications

Figure 1 shows the functional diagram and truth table of the 4093. Each of the four states is individually accessible and can be used as either a normal NAND gate or an inverting Schmitt trigger by using the connections shown in Figure 2. All unused inputs of the package must be tied to the positive or negative supply rails, as appropriate.

Figures 3 to 5 show basic ways of using a 4093 gate as a Schmitt trigger. Each gate has a typical hysteresis voltage (difference between the upper and lower trigger threshold voltages) of 2 V when powered from a 10 volt supply. In
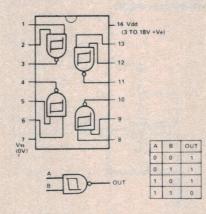

Figure 1. Functional diagram of the 4093 and operating truth table (for a single Schmitt gate).

A	B	OUT
0	0	1
0	1	1
1	0	1
1	1	0

Figure 2. As the gates in a 4093 have a NAND function normally, they should be connected as above to operate as an inverting Schmitt trigger.
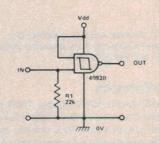

Figure 3. Simple Schmitt trigger with dc input.

Figure 3 the input signal is direct-coupled to the gate input. In the Figure 4 sine/square converter circuit the input signal is ac-coupled and the input pin is biased at half-supply via R1 and R2. In the improved sine/square converter circuit of Figure 5, the input pin bias can be adjusted to mid-way between the upper and lower threshold values, to give maximum sensitivity.
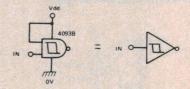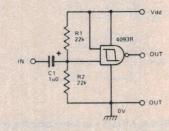

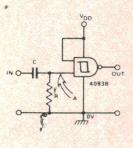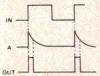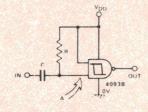Figure 4. Simple connection for use as a sine/square converter.
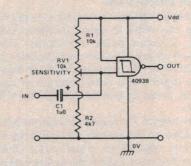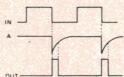

Figure 5. This circuit greatly improves the sensitivity when using the 4093 as a sine/square converter.
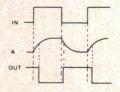
Lab Notes

Figure 6. **To trigger on the rising edge of a pulse, a CR network is added to the input.**

Figure 7. **A re-arrangement of Figure 6 to produce a falling-edge trigger.**

Figure 8. **How to obtain a delayed and inverted version of an input pulse.**
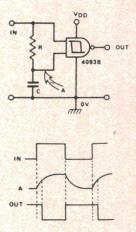

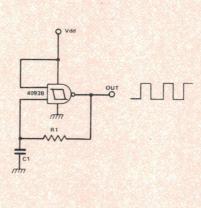Figure 9. **How to shorten a pulse by delaying the leading edge. Output is the inverse of the input.**

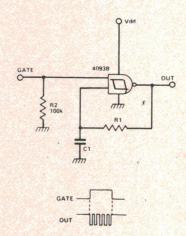Figure 10. **A basic astable multivibrator. The frequency of oscillation depends on the values of R1 and C1 and the hysteresis.**

Figure 11. **A variation on the circuit in Figure 10 allowing gated operation of the multivibrator.**

Edge Detection

Figures 6 to 9 show a variety of ways of using the 4093 to detect or delay the edges of input pulse waveforms. The figure 6 circuit gives an output pulse on the arrival of the rising or 'leading' edge of an input pulse. The duration of the output pulse is determined by the CR values.

The Figure 7 circuit produces an output pulse on the arrival of the falling or 'trailing' edge of an input pulse. The Figure 8 circuit delays the entire input pulse by a period determined by the CR values. The circuit in Figure 9 delays the leading edge only.

Clock Circuits

Figure 10 shows how a single 4093 gate can be used as an astable multivibrator or 'clock' generator. This circuit gives excellent performance with very clean output edges that are unaffected by supply line ripple and other nasties. The operating frequency is determined by the CR values and can be varied from a few cycles per minute to 1 MHz or so. The circuit action is such that C1 alternately charges and discharges via R1. Capacitor C1 can be a polarized component.

Figure 11 shows how the basic astable can be gated on and off via an external

signal. Note that the circuit is gated ON by a high input, but gives a high output when it is in the OFF state.

The basic astable circuit of Figure 10 produces an inherently symmetrical output waveform. The circuit can be made to produce a non-symmetrical output by providing the timing capacitor with alternate charge and discharge paths, as shown in the circuits of Figure 12. This circuit produces fixed mark-space ratio output.

Figure 13 shows a special-purpose voltage-controlled astable which operates only when V_{in} rises above the upper Schmitt threshold: the operating
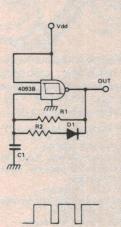
Figure 12. **How to obtain a non-symmetrical mark-to-space ratio for the astable multivibrator.**
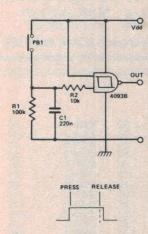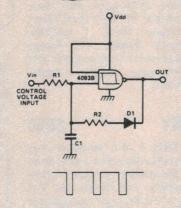

Figure 13. **The frequency of the astable may be varied by varying Vin shown here. However, Vin must be higher than the upper Schmitt threshold to start with. As you increase Vin, the frequency will increase.**
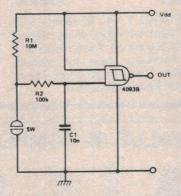

Figure 14. **"Debouncing" a press button switch. Such circuits are widely used in logic applications.**

Figure 15. **A touch switch that provides a *high* output when operated. If you swap R1 and SW the output goes *low* when you touch SW.**
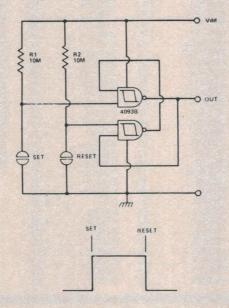
Figure 16. **A 'latching' or 'bistable' touch switch using two gates from the 4093.**

frequency then rises as V_{in} is further increased.

Miscellaneous

Figure 14 is the circuit of a 'noiseless' pushbutton switch, which produces a clean output pulse each time PB1 is operated. C1 charges up rapidly when PB1 is closed but discharges slowly with a period that is long (relative to normal noise spikes) via R1 when PB1 is released.

The output of the circuit in Figure 15 goes high when the input contacts are touched. A latching or 'bistable' touch-activated switch is shown in Figure 16.●

Ideas for Experimenters

Power monitor

These days we are all made to be aware of energy consumption and the relative efficiencies of devices within the group/class of interest.

Here is a simple circuit for determining the energy consumed by a device that would normally plug into a mains outlet and is in the power range of 100 W to 2400 W. Now, power (P) can be calculated from I x V but energy is P x t (where t = time), hence the provision for gating a timer. When the device under test is turned on, the current generates a field in the secondary of the transformer and the resulting ac voltage is rectified and used to operate a small relay whose contacts can control a gated timer. Note that the transformer is in the neutral line to ensure minimum isolation requirements. The transformer is made using ferrite cup cores (e.g: type FX2242) and the number of turns is not critical, being approximately 10 turns of 14g enamelled copper wire for the primary and 250 turns of 26g enamelled copper wire for the secondary. Be sure to insulate well the secondary from the primary winding. The relay may be any small 5 V reed relay type (e.g. Spectrol RA30451051). The voltage monitoring points have a "press to read" switch on the active side for safety reasons.

Naturally, for highly inductive/capacitive loads, the phase angle must be taken into account when calculating power.

The ac power monitor is particularly useful for determining the efficiency of thermostatically controlled devices such as refrigerators and small heaters.
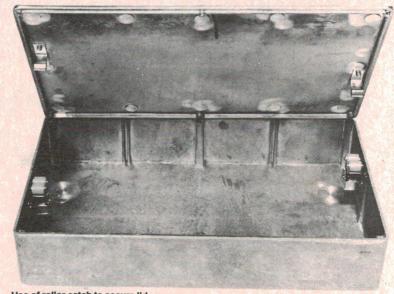
The power monitor has been in use for some time at the Canberra College of Advanced Education, being used mainly by engineering students determining the efficiency of a refrigerator over short and long periods, according to **Graham Knight of Holder, ACT,** who submitted the circuit.

Easy-lift lid

This is a construction hint which **A. Bendeli** from the **CSIRO Division of Applied Physics, Sydney, NSW,** found very useful during the development of several enclosures to house electronic hardware. It may be handy to home constructors who often need to get inside their black box for modifications, additions or repairs.

Usually, the lid of an instrument box is held down with a minimum of two screws, if not more. When the lid is removed, several screws are taken out (with the possibility of losing some!), the modifications carried out, and the lid refastened.

The following hint will eliminate the need for a screwdriver and reduce a lot of wrist action. In the picture, two roller catches of the type used to lock kitchen/laundry cabinet doors have been used. (Magnetic catches are not as effective.) The roller part is attached to the internal side of the box, while the striker part is fixed to the lid. The very strong spring action of the catch effectively

Use of roller catch to secure lid

clamps the lid down while still allowing it to be levered up when a reasonable pressure is exerted. This method has been used on Horwood cases, Eddystone boxes and other varieties of cases, according to the writer, who notes that the same technique is applicable to the rear panel of an instrument box.

Ideas for Experimenters

(Corrected circuit, from Dec. '80 ETI, p.80.)

LED chaser

This simple circuit for a LED chaser comes from **M. Spokes of Glen Iris, Vic.** The circuit uses a 555 oscillator driving a 4017B counter. RV1 is used to vary the rate of the chaser by varying the oscillation frequency of the 555. The

output of the 4017 drives ten LEDs, but with a suitable interface it could be used with light bulbs.

Simple square wave generator

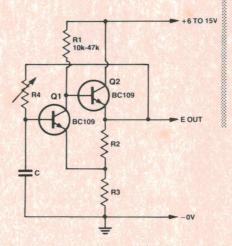This circuit employs a non-inverting amplifier using two transistors with an RC network in the positive feedback path between the output and the input.

Benjamin Simons of Beecroft, NSW submitted the circuit and explains that it works as follows: when power is first applied, C is not charged and Q1 is not conducting. Q2 is thus hard on and its emitter will be at a potential near Vcc. Capacitor C will charge via R4 until Q1 begins to conduct. This will cause Q2 to cease conducting, and as the action is regenerative, cutoff will be very rapid. The voltage on the emitter of Q2 will then fall to a voltage determined by the ratio of R1 to R3 and C will discharge through R4 until Q1 cuts off and the whole cycle repeats itself.

The transition time is extremely rapid and the rising and falling edges of the square wave produced have very short durations. The circuit will work with many common small signal transistors and pulse repetition rates beyond 500 kHz can be obtained. The output has very nearly an equal mark-

to-space ratio over a wide frequency range. This can be trimmed if required by adjusting the ratio of R2/R3, or by placing a small value 'trimming' resistor in series with the base of Q1. Top frequency will be influenced by the input capacitance of Q1 and circuit strays.

Copying pc board designs

Bill Materna of Kilkenny S.A. found an easier way of copying a circuit board design that "... is as old as kindergarten games".

Simply hold the design over the prepared piece of blank board and with a compass or sharp scriber make pin pricks through the drawn component holes on to the board. Then it is a simple matter of joining up the marks with a resist pen.

Any ideas ?

Have you had a bright idea lately, or discovered an interesting circuit modification? We are always looking for items for these pages so naturally, we'd like to hear from you.

We pay between $5 and $10 per item — depending on how much work we have to do on it before we publish it.

The sort of items we are seeking, and the ones which other readers would like to see, are novel applications of existing devices, new ways of tackling old problems, hints and tips.

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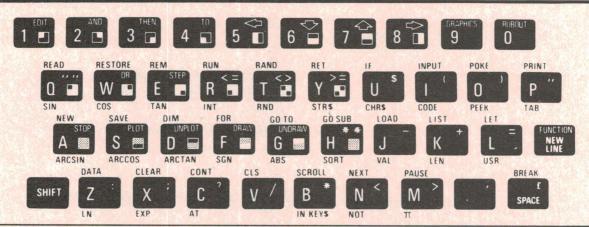**BP60** $5.30

Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project — check with our advertisers if it is not mentioned here.

Details on obtaining the Series 5000 heatsink/front panel have been included in the article, but note that a number of suppliers will be carrying stocks. In Sydney, try Jaycar, Electronic Agencies and Radio Despatch Service. In Melbourne, try All Electronic Components, Rod Irving Electronics and Ellistronics.

ETI-682 PROM board

The only 'unique' component for this project is the pc board. We understand they are available mail order from the copyright holder, TCT Micro Design Pty Ltd, P.O. Box 263, Wahroonga 2076 NSW. TCT have indicated they will be making the pc boards available wholesale, so some retail suppliers may be stocking them. For those adventurous souls willing to tackle their own board, a good quality print of the artwork is available by sending a large, stamped, self-addressed envelope to:

ETI-682 PROM PCBs
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011.

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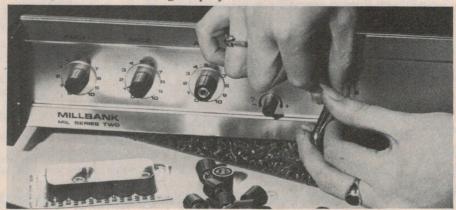
ETI-572 pH meter

December issues's pH meter has aroused a lot of interest (apart from our little stuff-up with the azaleas, camelias, potatoes and tomatoes in the article on 'pH — the acid test'). It brought to light another source of suitable pH electrodes. A letter from Phillip Gower, Service Engineer for Linbrook International Pty Ltd, advises that Linbrook are agents for an American-made range of pH meters and electrodes. Their cheapest probe costs around $50 and Mr Gower feels that it would be an eminently suitable companion to the ETI-572 pH meter project. He goes on to say that this probe is virtually unbreakable, having an epoxy body, and is easy to use and maintain as the reference electrolyte is a gel and hence never dries out or needs replenishing, nor is it necessary to store the electrode with the sensing end immersed in distilled water.

Enquiries to Linbrook International, Sydney (02)438-4322; Melbourne (03)690-4677; Brisbane (headquarters) (07)391-1969; Adelaide (08)337-8963 and Perth (09)446-9455.

Styro and SM capacitors

Styroseal and silver mica (SM) capacitors have been specified in a number of our projects recently (e.g: the pH meter and metal detector in December) and some readers have been enquiring where to obtain them. In Sydney, Radio Despatch Service and Electronic Agencies are stocking them, and sometimes you'll find them at David Ried Electronics. In Melbourne, try Ellistronics, All Electronic Components and Rod Irving Electronics. In Perth, try Altronics.

Collett knobs have many advantages over conventional grub-screw knobs, not the least of which is a better grip and being able to fit where grub-screw knobs will not. C & K Electronics, P.O. Box 101, Merrylands NSW 2160, market the British-made SIFAM range which comes in a variety of cone, pointer, figure-dial and nut cover types in six sizes from 10 mm to 38 mm diameter and matt finish colours of grey, black and red.

LETTERS

Dear Sir,

I can understand "Depresst C-Ber" wanting a nom-de-plume used instead of a name if he/she is fair dinkum (ETI January 1981) because of: (1) The illegal operation of transmitting equipment (self confessed pirate CB operator); (2) What sounds like considerable modifications to obtain more than the permitted 18 channels; (3) Operation outside the range of frequencies allotted for CB use and, going by the claimed coverage of 25, 26, 27, 28 MHz (or to use more of the writer's terminology, "mghs"), it would seem that something here is being used other than a CB rig that has multiband capabilities, as I cannot see the phase-lock loop system as used in CB rigs covering 3 MHz as claimed by the writer; (4) The use of gain antennas, the main purpose of CB radio being short distance communication.

Why should you, "Depresst C-Ber", make demands like the removal of restrictions on antennas and power, when no one else gets these privileges?

As for the claim of the P & T Department "cutting 27 mghs" (your words) — well, for a start there are such things as international rules and regulations governing this (ITU) to which Australia was a signatory (I hope that this is the right word), and besides you were not allotted 27 MHz on a permanent basis. Then there is the Morse code qualification (why should this be required of some and not others?).

So you want 40 channels and claim that if you were granted 40 channels you would get a licence. How very big of you. Well, you can have 40 channel operation by operating on 476 MHz.

As for your claim that certain people will stand to lose anything up to $600 (?), you must remember that you were not given a guarantee of permanent ownership of any section of the HF spectrum. Remember that other sections of the community have to take the same risks in this field as well as other fields. Money-wise, if you must blame someone then I suggest you blame those firms that brought a lot of this equipment (CB) into the country when they were only too well aware of the above situation, and undoubtably ripped many off. As you, "Depresst C-Ber", do not have a licence of any form from the P & T Department, I do not see how you can complain. So may

I suggest that you obtain some form of licence, if you are capable. It must also be pointed out that when CB radio was introduced into America, channels around 476 MHz were originally allotted for use by this service.

However, enough said for the time being. You can publish my name.

Graham J. Muirhead
Magill S.A.

Dear Sir,

In reply to "Depresst CBer or something similar" (ETI January 1981), your arguments are not only hypocritical; they are also totally illogical.

Firstly, may I say on what grounds I base my remarks. I have been on 27 MHz since late 1975, have been the president of a large and respected CB club, have been involved in the fight for Citizens' Band radio since 1976, and have sold and serviced CB radios since mid 1977.

May I ask why you would "go legal" and buy a licence if 40 channels became legal, but won't buy one when 18 channels are legal? This sounds like rubbish to me — perhaps you are trying to justify your comments. If you are pirating, there is no reason to pay extra money for the privilege, unless, like myself, you are only going to license one rig and hide the others.

Secondly, what on earth would you want a five-element beam for if the reception in your area is as good as you say ("some days it is hard to find a clear channel in these frequencies")? I would be overjoyed to be able to have all the legal channels full some days. There is no reason you would need a five-element beam except to talk skip around the world, and in my opinion that defeats the purpose of DXing — it's more of a buzz to talk 600 miles on a Realistic mini-23 through a ¼-wave helical than it is to talk 6000 miles using the equipment you want to run. Sure, you get more QSL cards your way, but that's like collecting stamps and only buying ones from the post office without trying to complete the collection.

Can you imagine the confusion that would occur if there were no limitations on antenna size or power output? No, I guess you couldn't. Those in the know (people on CB just after Christmas of 1977 — the first 'legal' Christmas) are totally against excess power and gigantic directional antennas.

Lastly, to all those people who may agree in principle with "Depresst C-Ber": be happy that Aunty PAT gave you 18 channels — we may have ended up like New Zealand.

R. Davies
Manly NSW SEC 1

Sir,

I think that the views of Depresst C-Ber (ETI, Jan. 1981) are selfish and pay little regard to other users of the radio spectrum.

Firstly he says, "We want no restrictions" on either antennae or power. Can you imagine the effect of a beam of 20 dB gain pushing the 'minimum' of 25 watts pointing at your antenna connected to a standard CB with no add-ons? That beam would be putting out the same power as a quarter-wave pushing 2499.9 watts (2.5 kW); there would probably be a bad case of fried CB, not to mention all the additional TVI and BCI.

Next I find it hard to believe that he will become licensed if the 40 channels he wants or rather 'we' want are given to us. I don't think he would drop down from 400 channels to 40!

Don't get me wrong, I'm all for more channels, 42 preferably, but I don't think that pirates with hundreds of channels will become licensed even then.

My only suggestion to Depresst C-Ber is to learn Morse and radio theory, as I am now doing, and become a ham.

Craig Orr (VCL-525)
Templestow Vic.

Sir:

No wonder the hazards of RF are disputed (ETI, Jan 1981). The major effort has been to deny any health risks instead of researching them. The US Navy even cancelled its project which it hoped would disprove such risks when, in fact, the data began to prove the converse.

The US government is already paying compensation to several hundred ex-servicemen injured by microwave (radar) exposure, yet it allowed its "safe" level to be set by the very groups whose vested interests are best served by maximising that limit.

When the Soviets (whose RF limit is one-thousandth that of the US) once flooded the US embassy in Moscow with microwaves at *well below* the US maximum, the staff were made to undergo medical checks — the results were never published — and the building was heavily screened.

If the US level is *truly* safe, why then the loud screams over that stupid joke?

While the vested interests scramble to get their act together, recall that self-styled experts once insisted that *all* RF radiations were absolutely benign!

George Lindley
Redfern, NSW

COMMUNICATIONS

Channel 0 to go —

Multicultural TV eventually UHF only, says Minister

Our February issue Editorial attacked the allocation of channel 0 to the IMBC for their multicultural TV service, pointing out, among other things, that no statement had been made on just what the 'interim' broadcasting arrangements were to be.

Just before the February issue went on sale we received a copy of a letter from the Minister for Communications, the Rt. Hon. Ian Sinclair, to the convenor of the Sydney Channel 0 Action Committee, that indicates channel 0 will eventually be phased out. Here is the letter:

MINISTER FOR COMMUNICATIONS

Deputy Leader of the National Country Party of Australia
Leader of the House   Member for New England

Mr S. Voron
Convenor
Sydney Channel 0 Action Committee
2 Griffith Avenue   17 DEC 1980
EAST ROSEVILLE   NSW   2069

Dear Mr Voron

        You wrote recently expressing concern over the allocation of channel 0 for multicultural television.

        Initially, I should reaffirm that it is the Government's intention that multicultural television will eventually be available on UHF only. The present dual transmission on channel 0 (VHF) and channel 28 (UHF) in both Sydney and Melbourne naturally allows many more people in these cities to become familiar with the service than would be the case had it been introduced on UHF only. All Media Releases issued by my predecessor in relation to this service have indicated the temporary nature of the channel 0 transmissions. I note that you have written directly to the Special Broadcasting Service in relation to their promotion of multicultural television.

        Your comments are noted concerning the effect of channel 0 transmissions in the Sydney area on amateur radio research at 50 MHz and I can assure you that my Department does not recommend the continued use of channel 0 in any Australian capital city on fundamental long range spectrum planning grounds.

        In relation to the development of UHF services generally, I am enclosing a copy of my predecessor's recent Media Release on this matter which indicates the increasing use of this band for television purposes.

        Although I am unable to indicate at this stage when the channel 0 transmissions will be withdrawn in the Sydney area you may be assured that I have brought your comments on this matter to the attention of my Department and that they will be kept in mind during the further development of the multicultural service.

                                    Yours sincerely
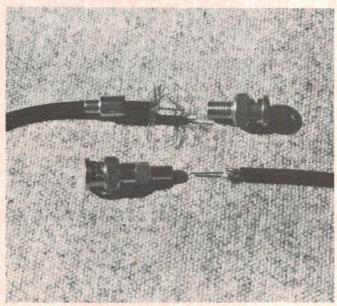
                                    (Ian Sinclair)

Parliament House, Canberra, A.C.T. 2600   Telephone (062) 72 7578
37th Level, Australia Square Tower, Sydney   Telephone (02) 241 1651

We eagerly await further developments.

'Fastfit' BNCs

Amateur radio enthusiasts looking for a BNC connector which eliminates the time-consuming assembly usually necessary with conventional models, can now buy the "Fastfit" series in Australia.

The series, distributed by J.A.L. Enterprises and retailing in hobby and electrical shops, features a field-installable one-piece model (the CPF188) which requires no contact soldering or crimping, no additional parts such as loose clamp nuts, insulators or sub-assemblies, and no wrenches.

The connector can be used for such applications as amateur VHF equipment and antenna connections. The fitting operation takes about 40 seconds.

A two-piece crimp version (the CP88) is also available. It requires only crimping of the braid, thus making assembly easier, consistent and quick.

Both connectors have a nominal impedance of 50 or 75 ohms, a peak voltage rating of 500 volts RMS and a dielectric withstanding voltage of 1500 volts. Insertion loss is less than 0.1 dB at 2 GHz with a VSWR of 1.05:1 at 1 GHz and 1.2:1 at 2 GHz.

The connectors, made by Cambridge Products Corporation in the US, are of bright nickle-plated brass construction with high density polyethylene insulators.

Trade enquiries should be made to the Australian agent: J.A.L. Enterprises, 71 Narrabeen Park Parade, Warriewood NSW 2102. (02)913-7871.

Welcome to Computing Today!

This issue heralds the introduction of a complete new section in ETI covering the booming field of personal computing.

As no doubt you've already noticed, we've re-organised the format of the magazine slightly.

While our long-established 'news' column on micro-computing remains — Printout — we've headed the section with this page which will generally carry the 'hot' news stories. Following Printout you'll find features (this month, one on bubble memories), hard-ware articles (this month a PROM board project) and soft-ware articles (back next month). Phil Cohen's series on Back Door Into BASIC continues this month; the concluding article will appear next month. Later in the year we'll have a series on Advanced BASIC — not to be missed!

In April Computing Today we have planned to reveal 'The Secrets of the Z80!' plus review the Instructor 50 micro-processor trainer and the new Ohio. We have also planned a feature on 'Universal Logic', a circuit technique that might arrive sooner than you think. The lucky winner and runners up of our Sinclair ZX80 Contest from the December 1980 issue should be announced and we also plan to introduce some new software columns covering the popular machines.

It's all happening — in Computing Today, each month inside ETI.

NEC's micro to compete with Apple II

The NEC 32K model PC 8000 microcomputer will be marketed against the Apple II, according to news from the US's winter Consumer Electronics Show held in Las Vegas in January.

Interest in the machine amongst US retailers was re-ported as 'strong' and deliveries should commence this month. Priced against the Apple II, delivery appears to depend solely on NEC ironing out specific distribution plans. American NEC's Consumer Electronics and Systems di-visions both want a crack at marketing it.

NEC was not alone among Japanese manufacturers in dis-playing items at the show. Casio, which showed its 4K FX 9000P, said it would make the product available toward the end of the third quarter. The firm has yet to set a price, but according to Don Coffelt, national sales manager, the unit will come in at around US$995.

Sharp showed its calculators, but not its YX 3200 small business computer.

Matsushita, which reportedly has its Panasonic subsidiary at work on a home computer, displayed a briefcase-style handheld computer under both the Quasar and Panasonic logos.

The unit is set to sell for around US$700 for the 4K handheld keyboard module, and at close to US$2000 for a package with a complete set of peripherals. These hook into any of six entry ports and in-clude extra money cartridges, a ROM expansion, a 16-character thermal printer, and an RS-232 interface. Quasar plans to sell the computer as the Quasar handheld computer and Pana-sonic is calling it the RL-H1000.

ETI/Dick Smith System 80 Contest results

This contest attracted an extraordinarily high level of entries — over 50% of entrants correctly answered six of the eight questions. Five per cent scored seven out of eight, and 20 people had all-correct entries.

One fascinating and unexpected result was that both winners were women — as were over 50% of the finalists.

Congratulations to Su-Ann Hoffman of Belair, Adelaide, winner of the general section. Likewise to Judy Linton from Sydney who won the second unit for her school in Enmore.

Herewith the winning answers . . .

1/ Many entrants disputed the choices given for the first question relating to Pascal's first calculator.". . . it was based on number wheels . . . most of the wheels had ten divisions for decimal reckoning. The two wheels on the right were different — one had twenty and the other had twelve divisions. Why?".

Included in the multiple choice answers was "One was for sous and deniers". This was the desired answer. However, many claimed that all Pascal's machines operated in 'tens' only.

Pascal's first machine — now in the Musée du Conservatoire National des Arts et Métiers de Paris — has eight wheels of which the two on the extreme right are actually marked as per our answer. A further reference:CONSTABEL P. et al., 1964 L'oeuvre scientifique de Pascal, Presses universitaires de France, Paris, describes this machine as a 'machine à six chiffres plus sous et deniers'.

2/ How much data was the memory (of Babbage's universal automatic calcu-lator) designed to hold?

The correct answer is 1000 words of fifty digits. There are innumerable references for this — we felt the best had to be 'On the mathematical powers of the calculating engine' by Charles Babbage himself, 26th December 1837.

3/ Inspired by Babbage's ideas a Swedish printer built a difference engine . . . What was the inventor's name?

We suggested the following: Pehr Scheutz; George Gutenberg; Hally Aller; Peter Ibsen.

Our desired answer was Pehr Scheutz. Gutenberg was of course the man first (and totally wrongly) accredited with the invention of the printing press. Hally Aller is actually a present day manufacturer of printing presses! Peter Ibsen, well . . . A very large number of entrants claimed that Scheutz' first name was Georg not Pehr. Nevertheless our sources give his name as Pehr Georg Scheutz. He is so called in 'The computer from Pascal to von Neumann' H.H. Goldstine, Princeton Univ. Press 1972.

4/ In 1947 Eckert and Mauchly designed a 'Universal Automatic Computer (UNIVAC). What did this have in common with Hollerith's tabulating machine of 1889?

The answer is that both were designed for use with the US Bureau of the Census.

5/ EDSAC had an unusual method of storing data. What was it?

Improbable though it may seem nowadays, EDSAC's main storage con-sisted of 32 tanks, each about 1.75 metres long, filled with mercury. The total main storage held 32 numbers of 17 binary digits, one being a sign digit. A number of short tanks were used for various registers and control purposes.

The best reference is probably the inventors' paper 'The design of a practical high-speed computing machine' M.V. Wilkes, Proc. Roy. Soc. London A195, (1948) p.274.

6/ Unlike several competing systems the Dick Smith System 80 is S 100 buss compatible. What is the S100 buss?

It is an internationally agreed system of interconnections.

7/ Dick Smith's System 80 is built around the Z80. No one had trouble with this one.

8/ No one had trouble with this one either. The System *does* have an in-built cassette recorder for data storage.

An amazing contest, which many people indicated they enjoyed be-cause of the difficulty and interest of the questions. Many thanks to the Dick Smith organisation for sponsoring the competition.

Australian manufacturers do their homework

Professional Australian Systems Pty Ltd (PAS) have just released the DYAD R1 School Computer — developed and manufactured in Australia for the Australian education environment.

In developing the Dyad, PAS took the Victorian Education Department's list of requirements for a school computer as the minimum specifications and came up with a product that is both unique and brilliant.

The Dyad can be acquired by schools in a modular way and is completely compatible with the popular Apple II. When interfaced with the Apple it will act as an intelligent card reader whilst still retaining its 'stand alone' capability for use in the classroom.

Priced at $2 950 it must be one of the most useful and vi- able machines yet to be offered to schools, technical colleges and universities. The price includes card reader, CPU and a dot matrix 125-character-per-second printer. Video display and floppy drives are available as options.

Features include automatic 8K BASIC with power on, remote program preparation on University-type cards, batch processing via an inbuilt card reader, automatic aborting of program errors, immediate printout of student feedback with program errors, 4K memory standard (with an optional 32K RAM board), and full warranty backup. Interfaces in-

clude one serial I/O port (RS232C) for terminal and printer, 18-bit parallel port for external use and an internal parallel port for the card reader.

Language capabilities include BASIC and Pascal on ROM, Assembler and Editor with the disk subsystem, and facilities for other languages. The Dyad will also support commercially available software packages.

Documentation is excellent, with an Extension, HSC Course (Victorian) and BASIC Interpreter student manual.

The all-metal housing was obviously designed to keep little fingers out and to withstand the rigours of a school environment.

Too often in ETI we hear laments regarding lack of Australian design and products, so here's a chance for all the education departments to 'buy Australian' and implement a system that has been designed specifically for syllabus requirements.

Professional Australian Systems are located at 883A High Street, Thornbury Vic 3071.

New ROMs for HP-85

Users of Hewlett Packard's HP-85 personal professional computer can now expand their systems by plugging in plotters, printers and other peripherals.

This capability is achieved by an HP-IB interface module and three new ROMs that plug into ports in the computer.

The first, the new general input/output ROM, enables the HP-85 to control instruments and perform data acquisition over the HP-IB link.

The second, the plotter/printer ROM, adds to the system an easy-to-use, high-throughput HP 2631B serial printer and an HP 7225A graphics plotter.

The third new ROM, for matrix math, provides a powerful set of statements for working with one- and two-dimensional arrays as large as 60-by-60 with additional memory in place.

For further information contact Hewlett Packard Australia Pty Ltd, 31-41 Joseph Street, Blackburn Vic. (03) 89-6251. Branches in Adelaide (08) 272-5911; Brisbane (07) 229-1544; Perth (09) 386-5455; Canberra (062) 80-4244; Sydney (02) 887-1611. Also in Auckland and Wellington, New Zealand.

Yet another daisy-wheel printer

Dick Smith Electronics' new X-3265 daisy-wheel printer for word-processing offers ". . . top print quality for up to three carbon copies, proportional print capability and prints in both directions at 25 characters per second, plus having all the usual features required for word processor applications."

The X-3265 is compatible with the widely-available Diablo plastic print wheels, giving a wide range of type founts, and with Diablo ribbon cartridges.

An inbuilt 8005 microprocessor controls virtually all the printer's functions, giving reliability and quietness of operation.

The printer is suitable for direct connection to most word processors and small computers, and provides a full set of 96 printing characters.

The X-3265 Word Processor Printer costs $1995.00, and further information can be obtained by contacting Jim Rowe on (02)888-3200, or see your nearest Dick Smith store or dealer.

Compukit UK 101 kit computer

The Compukit UK 101, which comes in kit form, is based around the 6502 microprocessor and comes with 8K Microsoft BASIC in ROM, which means it is able to run programs written for the Apple, Pet or Sorcerer microcomputers with little change.

The 4K RAM, expandable to 8K, should be sufficient for most requirements, including game playing (a Space Invaders program is supplied free if the 4K RAM add-on is ordered with the kit!).

The Compukit 101 may be connected to any standard Australian TV set, although the display will be in black and white only.

The Compukit 101 includes a comprehensive construction manual, all parts, high quality PCB, 8K Microsoft ROM and 4K RAM. Cost of the basic kit is $595, and it is available by mail order from Melbourne House (Australia) Pty Ltd, 24 Peel Street, Collingwood 3066 Vic.

STOL 221 interface for WP

A new company, Inca Data Systems of Sydney, has developed and will market the STOL (Serial Telex Olivetti) 221 interface to enable the new Olivetti 121 and 221 electronic typewriters to perform as intelligent printing terminals.

The terminals can have either direct or modem connection, combined with full editing telex punching.

The new interface means the Olivetti will have wide ranging capability with most word processing and data processing systems, with the added advantage of major cost savings.

The company believes that by using the STOL interface with an $1800 Olivetti electronic typewriter, users will get on-line word processing capability for less than $2400.

For further information please contact Geoff Quayle, Suite 701, 7th Floor, 26 Ridge Street, North Sydney 2060 NSW. (02)436-2220.
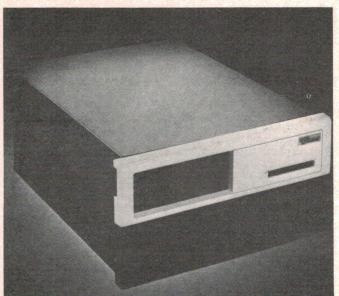
DOS for BASIC

Small computer users with DOS programs often encounter the problem that they are harder to use and understand than BASIC, so that when they add floppy disks to achieve faster and more efficient operation, programming becomes too complex for them to handle.

To counter this problem, Dick Smith Electronics now market MICRODOS (cat. no. X-3555), for use with the System-80 and TRS-80 systems. MICRODOS loads into memory to become a 'transparent' addition to the existing BASIC interpreter firmware in ROM.

It simply adds a set of additional commands to BASIC, so that all disk programming is done in BASIC itself. All the utilities accompanying MICRODOS are also written in BASIC for user convenience.

Cost of MICRODOS is $35.

Fine line graphics for TRS80

A fine line graphics unit is available for the TRS80, without modification connecting either to the CPU or by interface.

The unit contains its own power supply, is completely buffered, and software to generate any graphics is included in the package.

Totally an Australian invention and manufactured in Melbourne, the unit is available from DeForest Software, 26 Station Street, Nunawading 3131 Vic. DeForest Software have also recently been appointed as sole Australian distributors for the complete range of Instant Software products.

Panasonic

Ken Allen has taken up the new position of manager, dealership department, at The Computer Company, in line with the company's aim of maximising its National Panasonic microcomputer sales by extending its dealer network.

There has been a strong movement towards retail sales in the microcomputer market, and Mr Allen believes the early scepticism of professional computer people towards these machines is giving way to recognition that, far from being 'toys', microcomputers can play an important role for both small businessmen and within large corporations.

HP's portable printing terminal

A portable terminal featuring high-speed thermal printing, national keyboards and integrated mass storage has been introduced by Hewlett Packard.

The new HP 2675A terminal also offers selectable columns per line (132 columns on 8½" paper; 40 columns in expanded print mode, useful for titles, labels, etc.); underlined or framed characters for emphasis; and a standard line-drawing character set for printing forms.

There are eight user-definable softkeys which can be tailored to fit individual applications, and the RETURN key can also be programmed with up to 254 characters.

The thermal printer operates at 120 characters per second, producing a high-resolution 7 x 11 dot matrix for sharp character definition. It prints quietly, to fit into an office environment, and with its carrying case and weighing only 9.9 kg, it can be easily transported from one work location to another.

Optional keyboards may be ordered in Swedish/Finnish, Norwegian/Danish, French, German, United Kingdom and Spanish. There are four French keyboards: ASERTY and QWERTY, both with and without mute key.

With or without the national keyboards, the terminal can communicate in all six languages; typing a simple command is all that is needed to shift from one language to another.

The HP 2675A comes with built-in dual cartridge tape drives able to store 320K per removable tape. The updatable tape format allows recorded information to be updated and re-recorded over the same section of tape, and file access may be by file name, absolute file number, or relative position. Search/rewind is done at 90 inches per second, while read/write is 22 ips.

The HP 2675A is designed to require minimal training before operation, and automatic definition of softkeys, log-on messages, and program-calling when power is turned on greatly reduce the amount of training necessary.

For further information contact Hewlett Packard Australia Pty Ltd, 31-41 Joseph Street, Blackburn Vic. (03) 89-6351. Branches in Adelaide (08) 272-5911; Brisbane (07) 229-1544; Perth (09) 386-5455; Canberra (062) 80-4244; Sydney (02) 887-1611. Branches also in Auckland and Wellington, New Zealand.

Belden cable assemblies available

Acme Engineering of Victoria now stock a good range of Belden cable assemblies, including the RS-232-C and IEEE 488-compatible assemblies.

For data terminal and communications equipment employing serial binary data exchange, Belden's 8459 cable, built to meet EIA standard RS-232-C and types A to M standard interface, is used. This cable passes the FR-1 vertical flame test, and the 'D' type male and female connectors preclude any chance of mix-up. Acme stock these assemblies in five standard lengths, and bulk cable is also available up to 300 m.

The Belden IEEE 488 'General Purpose Interface Buss' (GPIB) cables can interconnect up to 15 programmable instruments in star or daisy chain networks. The 24-conductor cable assemblies are hard-wearing, and deliver good conductivity through their gold over nickel-plated beryllium copper contact pins.

For further information on these cable assemblies, contact Acme Engineering Co Pty Ltd, 2-18 Canterbury Road, Kilsyth Vic.

Zilog in W.A.

The complete range of the Z8, Z80 and Z8000 family of Zilog components is now also available in W.A.

Zilog Australia Products recently announced that Protronics Pty Ltd, who are at present distributing Zilog components throughout South Australia, will now also distribute them in W.A. through their newly established Perth office.

For information on Zilog products, W.A. customers should contact Protronics Pty Ltd, 24 Teddington Road, Victoria Park 6100 W.A. (09) 362-1044.

Acoustic modems to suit you

Electro Med recently released the new 700 Series acoustic modems, which are modular in design, enabling the user to tailor an acoustic modem to suit his own needs.

Users can now establish their own message exchange network that is faster than the conventional telex network by providing an originate/answer 700 acoustic modem and a visual or printing terminal at each end of the telephone line.

For further information contact Robert Powell, Electro Medical Engineering Pty Ltd, 69 Sutherland Road, Armadale Vic. (03) 509-5844.

New double-sided, dual flexible disk drive

A new double-density flexible disk memory providing up to 2.36 million bytes of mass storage capacity has just been announced by Hewlett Packard.

Each of the two drives in the HP 9895A flexible disk (why can't they call them floppies like everyone else? ...) memory reads double-sided, double-density format on HP-qualified flexible disks. The drive can store up to 590K per side for a total of 1.18M per disk.

The new drive is designed for use with technical computers, including the HP 1000 Series L, E and F, the HP-85 Personal Professional Computer, and the HP 9825, HP Series 9800 Systems 35 and 45 Desktop Computers.

The drive is also capable of reading single-sided disks written by the earlier HP 9885M or HP 9885S flexible disk memories, and can also in most cases exchange data with other systems using the IBM 3740 single-sided, single-density format, provided additional software exists on the host computer.

According to Hewlett Packard, the HP 9895 can provide up to 4.72M of storage capacity through an optional dual-drive slave unit. This is one of several options designed to give the user price/performance flexibility; all options can be easily upgraded to full HP 9895 capacity if later required.

The HP 9895 also has extensive self-test capabilities.

For further information contact Hewlett Packard Australia Pty Ltd, 31-41 Joseph Street, Blackburn Vic. (03) 89-6351. Branches in Adelaide (08) 272-5911; Brisbane (07) 229-1544; Perth (09) 386-5455; Canberra (062) 80-4244; Sydney (02) 887-1611. There are also branches in Auckland and Wellington, New Zealand.

ZX80 games

Melbourne House in England have recently published a book for users of the Sinclair ZX80 1K computer, claimed to be "the first computer in the world to be readily accessible and affordable".

Called '30 Programs for the Sinclair ZX80:1K' it contains programs for games such as blackjack, pontoon, mastermind, hangman, noughts and crosses, Lunar Lander, horse racing and many more, as well as educational programs such as maths drill, simultaneous equations, square roots and capitals of the world.

Perhaps as important for ZX80 users as the programs themselves are the programming techniques used, illustrating space compression, peeks and pokes, and USR function.

The most complex game in the book, Gomoku (a Japanese board game) is described as 'pushing the computer limits', and uses USR function and the screen display as memory to fit the game into the basic 1K memory.

Melbourne House claims to "have a commitment to providing literature and software for the ZX80", and will be publishing other relevant books, including 'ZX80 Machine Language Programming', in the future. They welcome programs or articles from ZX80 users, and will give you an assessment of whether they could use your material in one of their publications.

The book is available from Melbourne House (Australia) Pty Ltd, 24 Peel St, Collingwood Vic. 3066.

Instrumentation printer mechanism

Gulton MCS Division recently introduced the AP-40 TM, a fixed head thermal printer mechanism designed for instrumentation output requirements preferring text format.

AP-40 TM provides two fixed, twenty column dot matrix thermal printheads and a paper drive which feeds the paper under the printheads to exit in text format, first line at the top.

The drive roll is the only moving part, providing the quiet, highly reliable, maintenance-free operation typical of thermal printers. No electrics are included. The AP-40 TM interfaces easily with any microprocessor-based system.

The two Gulton printheads provide 40 columns of 5 x 7 characters 2.8 mm high and 2 mm wide, or tall characters (5 x 14) 5.6 mm high and 2 mm wide. Half step or half size characters and bold characters of normal height are also obtainable. Print speed is 150 lines per minute.

For further information contact Tecnico Electronics, P.O. Box 50, Lane Cove 2066 NSW; or P.O. Box 520, Clayton 3168 Vic.

New printers for TRS80
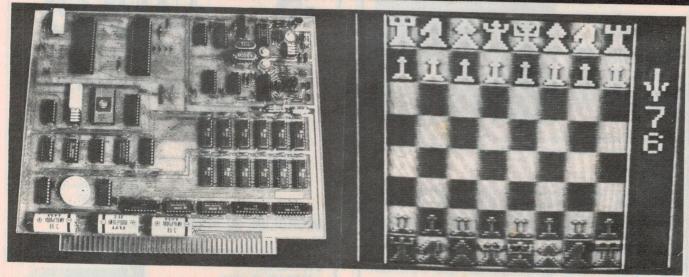
Complete Information Systems of Australia recently released two new printers for use with the TRS80 computer system.

The ITOH FP-1500 daisy wheel character printer produces 25 characters per second, with 96 characters, 136/line (10 CPI) or 163/line (12 CPI) columns, and provides a maximum of three copies.

The ITOH 1540 dot matrix impact printer features 136 columns and a print speed of 125 characters per second, and also has 96 characters with the standard ASCII code. It can produce four copies.

For further information contact the Sales Manager, Complete Information Systems of Australasia, 159 Kent Street, Sydney 2000 NSW. (02) 241-1813.

Colour graphics

Raydata recently announced a colour graphics card which can interface a microprocessor to an ordinary Australian colour television receiver.

The Pal Video Display Generator (PVDG) can generate up to eight colours, fine graphics, text and sound, and can be connected to a domestic PAL television receiver aerial socket.

The PVDG is self-contained and appears to a processor as 8K of static memory. It is Exorcisor buss compatible and can interface with 6800 family and 6502 type microprocessors. An S100 buss version is under consideration.

The video and colour information is generated by an on-board crystal clock and as such is independent of a processor clock. In normal operation, the composite video, colour and sound are modulated with the on-board RF modulator and connected to the aerial socket of the TV receiver. The receiver is then tuned to Channel 11.

The RF generator will also work on a black and white TV and will generate four levels of grey scale and sound. Output can be switched from RF to composite video output. The PVDG normally produces PAL colour, but can be ordered with NTSC-encoded colour output.

An on-board PIA can be initialised by a processor to produce 2 text modes, 2 semi-graphic modes, 8 full graphic modes and many different audible tones.

Further information can be obtained by contacting Raydata, P.O. Box 477, Gosford 2250 NSW, or B.H.P. Control Engineering, Victoria Road, Gladesville NSW.

Synertek System 65

A new development system for the SY6500 family of computers contains a Text Editor, Two-Pass Assembler and dynamic Debug package.

Supplied in ROM for maximum system reliability, it requires only the addition of a user-supplied TTY or RS232-compatible terminal.

The mass storage devices in this system are built in to the basic console, each drive providing storage capacity for 78K of source statements or object code.

The basic hardware comprises: two system CPU boards with processor, buss drivers, timing logic, system software ROM and RAM; I/O board for parallel and floppy disk control; 16K RAM board; internal power supply; front panel with power-on indicator, reset switch, single step switch, PROM programming socket and two mini-floppy disk drives; rear panel RS232, 20 mA current loop and Centronics-compatible printer, and scope synch connectors; power switch.

The Synertek System 65 has a wide range of edit, assembler and debug capabilities, plus a linked file capability to allow multiple files on different disks to be treated as a single assembly.

Enquiries should be directed to Royel Micro Systems, 27 Normanby Road, Notting Hill 3167 Vic. (03) 543-5122; or 15/59 Moxon Road, Punchbowl 2196 NSW. (02) 709-5293.

Editor/Assembler/Debug for System-80 and TRS-80

A new editor/assembler/debug program is now available for the System-80 and TRS-80 Level II computers.

Microsoft's Editor/Assembler-Plus, available from Dick Smith Electronics, combines the functions of existing editor/assembler and debug programs, at the same time adding many powerful new features.

At $39.95, the package sells for much less than existing equivalent products, according to the Dick Smith release, and comes complete with a comprehensive user manual and a handy command summary card. Catalogue number is X-3680.

Bubble memory operates to 70°
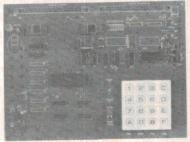
Intel Magnetics Inc. has begun marketing its 7110-1, a commercial one-megabit magnetic bubble memory device specified for operation to 70°C.

Intel Mag claims this improvement is significant because bubble memories will no longer limit the operation of microcomputer systems to temperatures below 50°C, and bubbles can now be used where disk and tape memories cannot.

For further information contact A.J.F. Systems & Components, 310 Queen Street, Melbourne 3000 Vic. (03)67-9306.

MENSA COMPUTERS

Suite 3, 454 St. Kilda Road, Melbourne, 3004. Telephone: (03) 26-5683, 26-6150.

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THE WORLD'S FIRST PORTABLE MICROCOMPUTER
Battery or mains operated

RAM 48K to 2 megabytes, bubble memory to 2MB, gas plasma display, optional audio, printer, mass storage mini floppys to 800K bytes, hard disk to 195 megabytes, acoustic coupler, S-100 bus, battery optional, CPU with real time clock. For dynamic businessmen on the move. Ideal for real estate agents, insurance brokers and accountants.

SUPERBRAIN™
Intelligent Video Terminal Systems

Powerful, multi-purpose microcomputer systems.

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Priced competitively from as low as $45.00 p.w. lease cost including sales tax and software.

TYPICAL APPLICATIONS

Debtors ledger and statements, creditors ledger and remittances, general ledger and trial balance, order entry/invoicing, sales analysis, payroll/wages, enquiry, word processing, mailing, record keeping, ledger card, doctors office, real estate, agency accounting, hotel/motel accounting, branch office accounting.

Also:
Facilities management consulting.
Software and computer sales.
Computer data preparation.

INTRODUCING

MENSA G.F. 1000

BASIC SPECIFICATIONS

CPU 8080 and Z80 operating at 4MHZ. 64K bytes Dynamic RAM expandable to 2MB storage bytes of unformatted data on two double density drives. Optional external hard disk storage can be connected using the optional S-100 Bus. Floppy Disk. All modules mounted to base. CRT in a rigid aluminium frame. Disk Drive assemblies are mounted into special brackets for ease of servicing.

WINCHESTER DISK
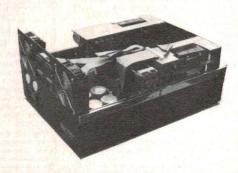
26MB of Winchester Disk complete with controller and easy backup. Disk has special capacity to only back up files accessed during the last period. Disk operating system CP/M.

OPTIONAL SOFTWARE

FORTRAN, COBOL, BASIC.
Application packages. Extensive software development tools are available from leading software vendors, including software for the following applications: payroll, accounts receivable, accounts payable, inventory control, general ledger and word processing.

Mensa computers provide a service network throughout Australia at major service centre locations to minimise response time to service calls. To ensure that equipment will operate at peak performance, engineers and technicians are trained to ensure the highest possible standard of service.

Rockwell 256 kilobit bubble memory type RBM256, photographed with a bubble memory chip on a finger, against a background showing a magnified part of the bubble chip's circuitry.

Behold — the bubble memory !

There is a gap between cheap, fast semiconductor memories and the slower, huge capacity, mass storage, magnetic memory media. It seems bubble memories, a relatively new technology, are set to fill the gap.

Brian Dance

ONE OF the major problems of modern electronics is storing relatively large amounts of data economically in small memory packages; this applies no matter whether one is designing a small pocket calculator, a data terminal, a large computer, a digital telephone exchange, an automated factory or any similar equipment.

Semiconductor memory devices provide rapid access to somewhat limited amounts of stored data, but in most types of such random access memories the data stored in the memory is lost in the case of power failure or if the equipment is switched off. It is convenient to store much larger amounts of information on magnetic tape, a floppy disk or a magnetic drum, but access to the information is far slower than in the case of semiconductor memory stores. Although the cost per unit of data stored in magnetic systems is low, reliability is not really adequate for some applications — especially spacecraft data storage.

Great efforts have therefore been made to develop memory equipment which can store large amounts of data in a relatively small volume at low cost per bit — preferably without the need for the motors or moving parts used with magnetic stores. These reduce reliability, especially in conditions of severe vibration or in other difficult environmental conditions such as corrosive atmospheres.

Bubble memories satisfy many of these requirements and also have the great advantage of non-volatility (which means that the data stored in the memory device is not lost in the event of the power being disconnected).

Speed

The bubble memory can fill the vital gap between the fast semiconductor memory and magnetic data storage systems. Currently available bubble devices have typical access times of the order of 1 ms; although this is much slower than that of semiconductor random access memories, which have access times of $1\,\mu s$ or less, and of magnetic core memory stores, which have access times of the order of $1\,\mu s$, it is much faster than the floppy disk ▶
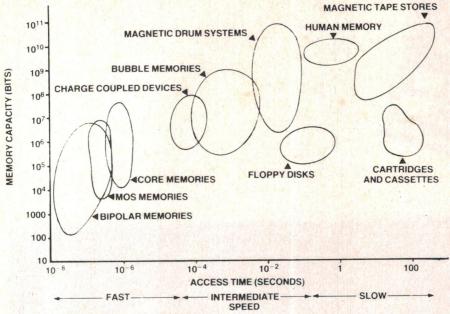
Figure 1. **Memory capability versus access time.**

and below the thin garnet film contained in the coils produce a fairly uniform magnetic field perpendicular to the garnet film. The bubble memory device is enclosed in a magnetic shield so that its operation is unaffected by any low intensity magnetic fields which may be present in its environment. As indicated in Figure 2, a bubble memory device requires quite a number of associated integrated circuits to develop the current pulses required to operate its coils, etc.

The thin film material of a bubble memory is easily magnetised in a plane perpendicular to that of the film. In the absence of any magnetic field, randomly distributed 'serpentine' domains are

Figure 3. **Bubble formation in a thin film of garnet.**

access time of perhaps 100 ms. Magnetic tape cartridges and cassettes have still longer access times — often over one minute (see Figure 1).

Cost is a vital consideration in memory devices which are to be used in quantity. The cost per available binary digit (bit) of storage space in a bubble memory currently exceeds that of magnetic storage systems, but is less than that of semiconductor memories. The storage density available in a bubble memory (amount of data storage space per unit volume) exceeds that of a semiconductor memory, but is less than that of magnetic systems. However, bubble memory storage density has considerably increased recently and there is every hope that this trend will continue.

What is a bubble memory?

Unfortunately the term 'magnetic bubble' is rather misleading, since it is used to refer to very small cylindrical magnetic regions or domains in a thin film of material. These domains are magnetically polarised in the opposite direction to the remainder of the film. This film consists of a special garnet crystal which is very uniform and which has the required magnetic properties. Typically, the thickness of this garnet film is only about one twentieth of the diameter of a human hair. The magnetic bubbles can be moved about in the film by means of electrical pulses applied to the bubble memory connections. The presence of a bubble corresponds to the binary digit '1' and the absence of a bubble at a certain point to binary digit '0'.

The techniques involved in the manufacture of bubble memory devices are very similar to those required for the manufacture of complex integrated circuits. It is not therefore surprising that

many of the world's semiconductor giants have become involved in the development and manufacture of bubble memories. Neither is it sur-

Figure 2. **An exploded view of a bubble memory device and supporting ICs.**

prising that bubble memory packages are somewhat similar to integrated circuit packages.

Structure

The structure of a Texas Instruments bubble memory is shown in the exploded view of Figure 2. Two coils with mutually perpendicular axes are wound on the magnetic bubble chip so that they can be fed with a current which will produce the required rotating magnetic field which moves the bubbles.

The two permanent magnets above

present. As the magnetic bias field is increased by bringing the two permanent magnets up to the film, the domains that oppose the field shrink in size (as shown in Figure 3) until they form small cylindrical domains or 'bubbles'. As these bubbles are magnetic dipoles, they interact strongly with one another and it is therefore normal practice to employ a bubble spacing not less than four times the diameter of a bubble.

Bubble diameters are typically a few micrometres, but there are intensive

efforts being made to construct bubble memories with smaller bubbles so that the amount of information which can be stored in a given chip area is increased by the use of more bubbles per unit area. However, special techniques are required to deposit very fine lines on the chip to reduce bubble diameters, the minimum diameter obtained so far in experimental devices being 0.4 μm.

Propagation

Propagation is the term given to the process of moving the bubbles from one location in the thin film to the next position. The paths in which the bubbles move are controlled by minute patterns of a soft magnetic 'permalloy' material deposited on the chip by photolithographic techniques. The patterns can be made to act as small electromagnets whose polarity is controlled by the external rotating magnetic field generated by the perpendicular coils wound around the chip.

One bubble memory pattern which is widely used is the asymmetric chevron pattern shown in Figure 4, but 'T', 'Y', contiguous disc and symmetrical chevron patterns are sometimes employed. The pattern of soft magnetic material is deposited on the surface of the chip above the thin magnetic film layer.

Bubbles can be generated in the thin film by passing a pulse of current through a microscopic metallised one-turn loop located on a secondary layer immediately above the magnetic film on the surface of the chip. If the current pulse is of suitable amplitude and polarity, it will produce a local vertical magnetic field of a polarity opposite to that produced by the permanent magnets and creates a bubble in that region.

A rotating magnetic field generated by the perpendicular coils around the chip can produce the magnetic polarities in the chevron pattern shown in Figure 4. These patterns can attract the bubbles and cause them to move to an adjacent position, as shown for the two bubbles in Figure 4.
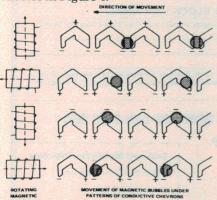
Figure 4. **Asymmetric chevron pattern used on the garnet film.**

In a practical device one must be able to detect whether a bubble is present at any position. A pattern of chevrons is placed at right angles to the output track and is used as a bubble detector. This output chevron pattern causes the bubbles to elongate and as they pass over a permalloy detector pattern, the magnetic field changes and this produces a change in the resistance of the permalloy elements. Thus detection is by a magnetoresistive effect. Two identical detector elements are placed on each chip and are used as two of the sides of a bridge circuit (Figure 5). A bubble passing over one of these detection elements produces the resistance change, which then appears as a signal of a few mV in the output of the bridge circuit
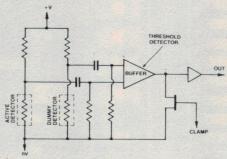
Figure 5. **Bubble detector circuit.**

Memory organisation

One type of bubble memory employs a single loop, as shown in Figure 6, the pattern of bubbles and blank spaces moving around the loop step-by-step when commanded by the rotating magnetic field from the perpendicular coils. The positions shown in Figure 6 in the loop correspond to locations on the chevron pattern of the actual bubble memory.

Although this single loop memory architecture is the simplest possible structure, it suffers from two principal disadvantages. The main problem is that when any bubble position has passed through the generator or detector, it must circulate around the whole of the loop before it can be altered or read out again. Access times to obtain information stored in such a loop are therefore very long, since modern bubble memories can store up to per-
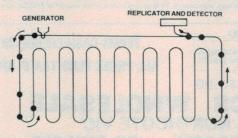
Figure 6. **Structure of a single loop bubble memory.**

haps a million bits of data and must therefore have at least this number of bubble positions.

In addition, a fault at any point in the single loop can result in the complete memory chip being quite useless. As it is difficult to produce bubble memories with a large data storage capacity and a high probability that every bubble storage position will operate satisfactorily, such a loop structure would result in a low yield of good devices if the loop were large. Such a low yield would inevitably result in a relatively high price per device.

For these reasons the manufacturers of high capacity bubble memory devices normally prefer to use a type of major-minor loop architecture such as that shown in Figure 7. Bubbles are generated and detected only in the major loop. Any bubble generated in the major loop can be transferred to a minor loop where it can circulate until it is to be read out from the memory. It must be transferred to the major loop before read-out can take place.
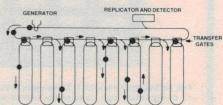
Figure 7. **Structure of a memory with a major-minor loop system.**

When data is to be entered, current pulses in a loop wire enter the bit pattern into the major loop. It is then moved along the major loop by pulses to the perpendicular coils until the first data bit in this loop is aligned with the most remote minor loop and each of the other bits is adjacent to one of the other minor loops. Current pulses to each of the transfer gates at this time produce localised magnetic fields which cause the transfer of all the bubbles in the major loop to the top bit position in each of the corresponding minor loops.

Any old data in such a bubble memory must first be removed by a destructive read operation before new data can be entered into the memory. Destructive read operations are effected by transferring the bubbles from the minor loops and running them into the permalloy guard rail surrounding most bubble devices, so that they are annihilated.

Reading of information from the minor loops is effected by rotating the bubbles in the minor loops until the required data is adjacent to the major loop. The block of data is then transferred in parallel (that is, simultaneously) to the major loop. The data block then moves through the major ▶

Behold — the bubble memory!

loop to the replicator-detector. The original data stream in the major loop continues to rotate in the loop until it reaches the appropriate minor loop, when transfer to the latter takes place so as to save the data for any further work which may be required.

In bubble devices using major-minor loop structure, a small number of the minor loops may be defective without the device operation being impaired, since enough minor loops are included on each chip to allow for a few defective loops to be redundant. Defective minor loops are found during device tests and are not used, so that a high device yield and hence a lower price is obtained. In addition, the use of major-minor loop structure greatly reduces data access time, since the bubbles have to be moved through only a relatively small number of positions before read or write operations can take place.

Availability

One-megabit bubble memory devices are readily available, although they are not cheap, but devices with a somewhat smaller capacity are more common. There is a considerable demand for devices with a greater storage capacity and some people have predicted that devices able to store over 100 megabits will be available by the end of the 1980s. By this time it is expected that the world markets for bubble memories will be worth perhaps $1000 million per annum, so it is no wonder that the semiconductor manufacturers have invested heavily in bubble memory development and production.

US manufacturers are well ahead in the bubble memory race, since they have developed these products from their semiconductor production techniques. Japanese manufacturers have also invested heavily in the bubble memory field, but Plessey is currently the only European manufacturer producing bubble memories.

Let us consider a few of the currently available devices. Texas Instruments produce a one-megabit device with a 0.965 cm² chip area. It has a major-minor loop structure, but is divided into two identical sections, each of which has 256 loops of 2048 bits each for data storage (see Figure 8). In addition, there are 26 redundant loops and 18 loops for error correction information. The access time is 11.2 ms with a 100 kHz field frequency. This manufacturer also offers devices with 512 kilobit and 256 kilobit capacity.

Intel Magnetics produce a bubble memory of one-megabit capacity, having
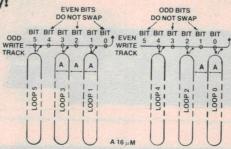
Figure 8. A 'block replicate' memory with major and minor loops divided into two identical sections. The data rate can be at least twice that in a simple major-minor loop system.

256 data storage loops, each with a capacity of 4096 bits. Thus it offers 1 048 576 bits of storage space, but up to an additional 48 loops can be defective and therefore redundant. Transfer time is 6.5 ms at a nominal 50 kHz rate.

Rockwell International produce a 256 kilobit bubble memory, having 260 data loops each with 1025 storage positions. Another 22 loops are available to provide minor loop redundancy. Four of the 260 loops are required for the system information storage and are not available for data storage. The operating power required is less than 1 W. The three parts of this device are shown in Figure 9. Rockwell also produce one-megabit memory boards containing four of their 256 kilobit devices.

Applications
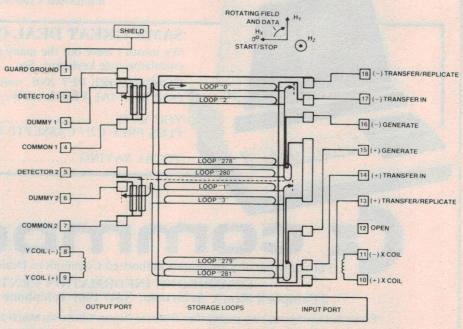
Bubble memories are already being used in quite a number of applications, although their price is still high enough to deter many people from using them in all the applications for which they are

technically suitable. High density devices have been available only since about 1978, when Texas Instruments introduced a 254 kilobit bubble memory.

Bubble memories with a high storage capacity have proved of value in space vehicles, since they are very light in weight for a given capacity; non-volatility and minimum power consumption are also important in this application.

In telephone exchanges bubble memories can be used to hold 'recorded' messages, which can be converted into an audio signal and played over the telephone to a caller whenever this is required. Bell Laboratories of the US, where the bubble memory was first invented in 1967, have developed equipment for use by the Bell Telephone System. Announcements such as "We're sorry, but the number you have reached is not working . . ." have been produced by Bell for many years with bubble memory storage. However, the major telephone application seems to be in giant telephone switching terminals to route telephone calls, where the major attraction of bubble memory devices is their high reliability and low maintenance costs. They are now in use in many telephone systems in various parts of the world. At one time it was thought that telephone applications would be the largest volume use of bubble memories and this may still be true.

In the general field of computer equipment (including replacement of the floppy disk), bubble memories have great potential, but at present they do not seem really cost-competitive ▶

Figure 9. The connections and loop structure of the Rockwell RBM256 device.

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with conventional memory systems, especially when one takes into account the fact that the incorporation of these devices into mainframe computers would involve a great deal of equipment re-design which would be quite expensive. Manufacturers such as IBM have not yet used bubble memories in any of their computers, although they are one of the world's foremost research establishments in the field.

In the computer field bubble memories are currently more suited for use in peripherals, such as display terminals, and in smaller special-purpose computers for military and other purposes, where their robust properties or other features are especially suitable. Eventually we may see large computers specifically designed to make optimum use of bubble memory devices. Similarly, bubble memories are likely to be used more and more in industrial control systems in factories, etc.

A Bell Laboratories engineer recording a 24-second message in the two magnetic bubble memories on the centre of the right-hand circuit panel.

The Rockwell AIM 65 low-cost microcomputer, which incorporates a bubble memory.

One may also expect bubble memories to be more widely used in the data logging field, including such fields as supermarket sales data, geological and oceanographic surveys, where reliability and portability of a high storage-density system may be more critical than initial cost. Texas Instruments produce portable data terminals using bubble memory storage for such commercial applications as remote sales order entering, computer time-sharing systems and newspaper reporting. Information from many sources can be stored on such a terminal (about the size of a large portable typewriter, which it resembles generally with its keyboard and carrying case); the stored data can be transmitted in a single batch over a normal telephone line using the built-in acoustic coupling unit. Data can be held indefinitely, so non-urgent information can be transmitted at times when telephone rates are a minimum. T.I. uses its 91 kilobit bubble devices in these terminals.

Future developments

As with most devices, the widespread use of bubble memories will be largely controlled by their price, while their price will largely be determined by the numbers used. It is the old story of which came first, the chicken or the egg! The development of smaller bubbles and therefore of denser devices will doubtless assist in the more widespread use of bubble devices for some purposes.

It is interesting to note that memories employing light bubbles have been developed. It is hoped that they will eventually enable low-cost, high-density memory systems to be produced using the new technology. Light bubble memories involve the formation of images in manganese-doped zinc sulphide films by stimulating specified areas with a light beam, an electron beam or an alternating addressing voltage to the area, using cross metallic lines deposited on the film; the effect of the addressing voltage is to induce light emission from the chosen region.

If the frequency of the applied voltage is raised to 10 kHz, the minute bubbles of light move from one location to another in discrete steps. The creation of a light bubble at one point seems to take place at about the same time as the bubble in an adjacent site is extinguished. If two light bubbles approach one another, they repel.

The light bubbles can be seen emerging from the appropriate areas of the zinc sulphide film under a microscope. The full theory of the generation of bubbles in the film is not yet known, but it seems that they are connected with the microscopic defects in the polycrystalline structure of the zinc sulphide film. Nevertheless, it will doubtless be some considerable time before devices using such light bubbles become commercially available, even if all the technological problems can be overcome.

Conclusion

Bubble memories are attractive devices for use when one requires a medium speed memory system for storing moderately large amounts of data at prices which are currently in the middle of the memory price range for each bit of memory capacity (Figure 10). Some devices have been developed which do not require the pair of perpendicular coils and these should be very attractive, at least in principle, since the coil operation limits the maximum operating speed, due to eddy current and skin effect losses in the metal of the device.
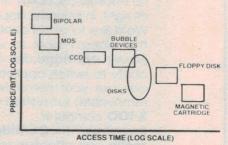
Figure 10. Cost per bit of storage space versus access time for various types of memory device.

S100 PROM board includes many features

Craig Barratt

Another in our series of S100 buss projects, this board will accept 2708s, 2758s, 2716s and 2732s and is arranged in two independent banks of eight PROMs capacity each. There's more, but read all about it!

THERE HAS been considerable debate over the past few years about how much read only memory a computer should use. Most computers have a small amount of ROM that contains a program which activates a monitor, assembler, BASIC or whatever from cassette or disk. Many other microcomputers, however, have large amounts of ROM. Examples are the Tandy TRS-80 and the ROM packs of the Sorcerer, which usually contain BASIC interpreters.

The disadvantage of having large programs in ROM is that if you want a difficult program it is not so easy to do. Nevertheless, such ROM-stored programs avoid time wasting cassette loading, and therefore programs stored in PROMs (programmable read only memories) are the perfect choice for dedicated micro applications.
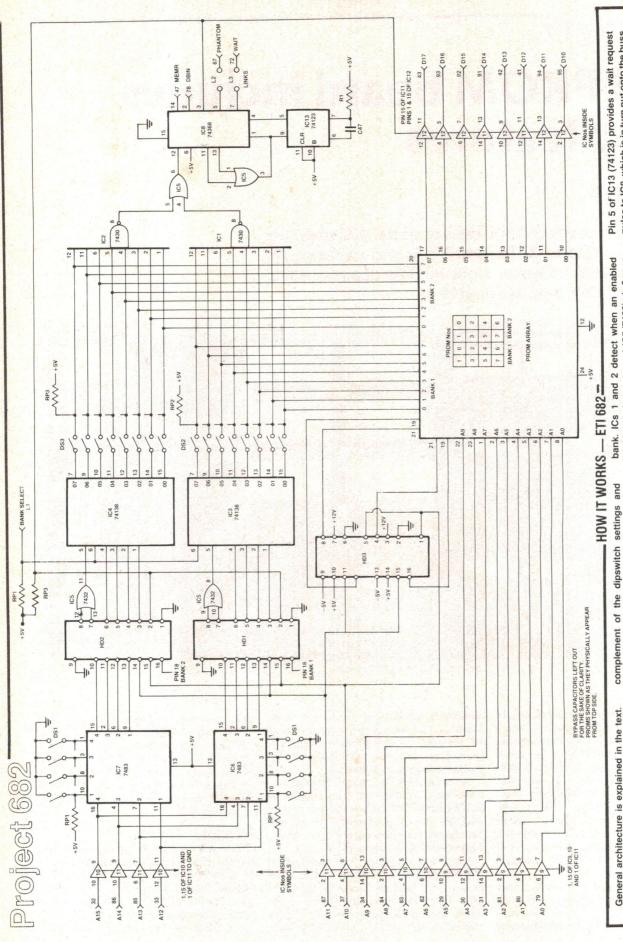
Over the last few years PROM prices have been falling nearly as rapidly as RAM prices. The increasing demand for PROMs has pushed down prices and prompted manufacturers to design bigger and better devices.

Only a few years ago the largest PROM available was the 1702, a 2K device arranged as 256 bytes by eight bits. The 1702 was superseded by the 2708, the very popular 1K by eight-bit PROM. Lately, 2716s and 2732s have been released, and rumour has it that 2764s are being designed! These PROMs are arranged as 2K-by-8, 4K-by-8 and 8K-by-8 respectively. When (or if) released, the 2764 will have 32 times the capacity of the old 1702, which indicates the scope of technology in this field.

Design features

These new chip releases make the design of a PROM board difficult. As soon as we designed a 2716-compatible PROM board, Murphy's Law would have it that 2732s would suddenly become cheap. So in our quest to design the 'best' S100 boards around we decided to ▶

HOW IT WORKS — ETI 682

General architecture is explained in the text. The only unusual aspect of this board is the address decoding circuitry. This circuit allows large blocks of PROM memory (i.e: 8K, 16K and 32K) to be located on 4K boundaries. This is achieved by subtracting the dipswitch setting (DS1) from the four upper address lines from the processor.
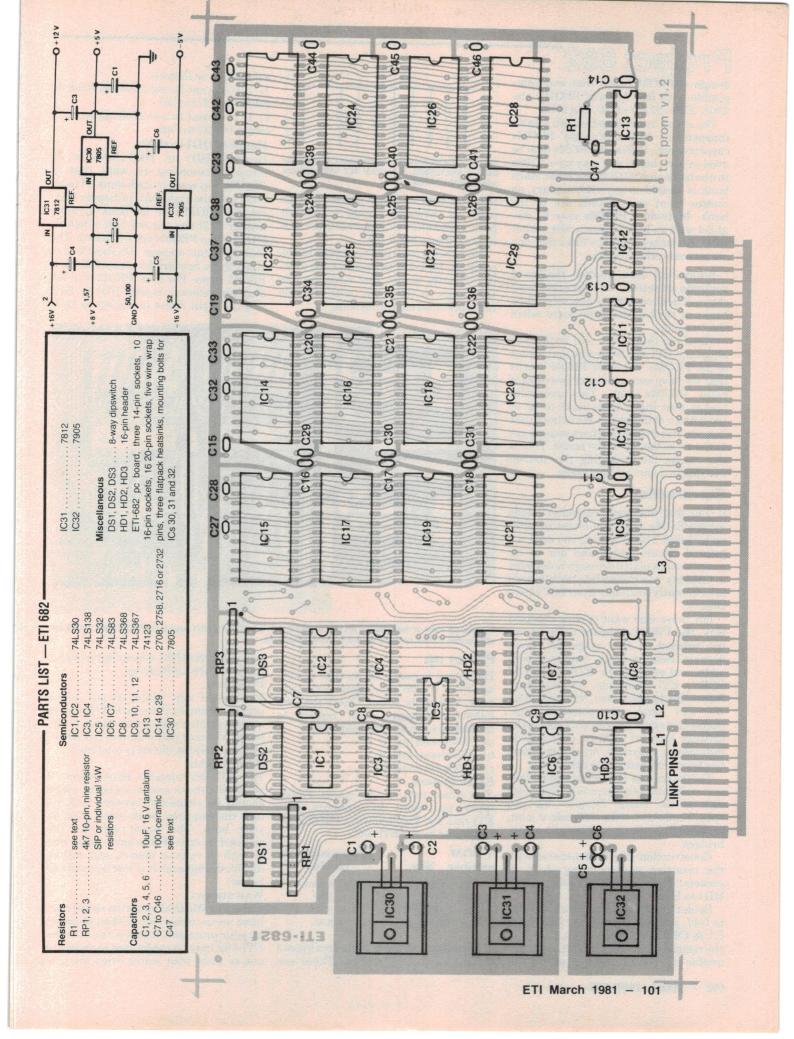
IC6 and IC7 (7483) are 4-bit adders for bank 1 and bank 2 respectively. By presetting the complement of the dipswitch settings and adding one (carry in = high) we are effectively doing a subtraction. Headers HD1 and HD2, for banks 1 and 2 respectively, map the outputs of the adders into the inputs of the address decoders (IC3 and IC4, 74138s), according to the PROM size.

The two enable lines of ICs 3 and 4 (pins 4 and 5) enable the decoders (74138) only when the processor is addressing memory within a

bank. ICs 1 and 2 detect when an enabled PROM is being accessed. IC5 (7432) pin 3 goes low when there is a read from an enabled PROM. This is used to turn on the second half of IC8 (74368). This then puts phantom and wait signals onto the buss, if required by the user. It also enables the data out buffers, ICs 11 and 12 (74367), when PDBIN is active.

Monostable IC13 (74123) is triggered whenever a read from an enabled PROM is detected.

Pin 5 of IC13 (74123) provides a wait request pulse to IC8, which is in turn put onto the buss as desired.

ICs 9, 10 and 11 (74367) buffer the address lines. A0 through A9 are connected directly to the PROM array and, for larger PROMs, A10 (2716) and A11 (2732) may be connected to the PROM array by configuring straps on header HD3 appropriately. Three supply rails (+5 V, +12 V and −5 V) are available on header HD3 and are used when 2708s are required.

100 — March 1981 ETI

PARTS LIST — ETI 682

Resistors
R1 .... see text
RP1, 2, 3 .... 4k7 10-pin, nine resistor SIP or individual 1/4W resistors

Capacitors
C1, 2, 3, 4, 5, 6 ...... 10uF, 16 V tantalum
C7 to C46 .... 100n ceramic
C47 .... see text

Semiconductors
IC1, IC2 .... 74LS30
IC3, IC4 .... 74LS138
IC5 .... 74LS32
IC6, IC7 .... 74LS83
IC8 .... 74LS368
IC9, 10, 11, 12 .... 74LS367
IC13 74123
IC14 to 29 .... 2708, 2758, 2716 or 2732
IC30 7805
IC31 7812
IC32 7905

Miscellaneous
DS1, DS2, DS3 ...... 8-way dipswitch
HD1, HD2, HD3 ...... 16-pin header
ETI-682 pc board, three 14-pin sockets, 10 16-pin sockets, 16 20-pin sockets, five wire wrap pins, three flatpack heatsinks, mounting bolts for ICs 30, 31 and 32.

LINK PINS ►

tct prom v1.2

ETI-682

design a PROM board that was compatible with four types of PROMs: the 2708, 2758, 2716 (+5 V), and 2732.

The board is arranged as two totally independent banks of eight PROMs capacity each. Different PROMs may be used in each bank; you may have 2708s in one bank and 2732s in the other. Each bank is located on any 4K boundary, no matter what size PROMs are in the bank. Individual PROMs may be disabled with on-board dipswitches, rather than the messy diodes or links that you see on some other boards.

Besides all these goodies, the board supports phantom, will generate wait states if desired and is bank selectable. Links at the bottom of the board select these options.

The first thing that will strike you about the ETI-682 is the unusual layout of the PROMs. All other PROM boards that we have seen consist of two rows of eight PROMs each. This generally means that dipswitches have to be at the bottom of the board. We believe that dipswitches should be where you can get to them: at the top of the board. This is the reason for arranging the sixteen PROMs in a four-by-four array.

Construction

If you feel that your computer needs some PROMs, then you ought to build an ETI-682. The first thing you need is a printed circuit board, and due to its complexity, a plated-through hole board is strongly recommended. Such boards are currently available from TCT Micro Design.

For those who want to do it the hard way, the PROM pc board patterns are not printed in this magazine. Don't despair! Send a large, stamped, self-addressed envelope to 'ETI-682 PROM PCBs', ETI Magazine, 15 Boundary Street, Rushcutters Bay, NSW 2011 and we will send the patterns back. (Remember that you can only obtain the artwork for your own use as a private individual; copyright on the pc board has been retained by the designer.)

The board has been designed so that no tracks run between pins on the solder side of the board. Despite this you should take care with each solder joint, watching out for dry joints and solder bridges.

Construction should commence with the insertion and soldering of all IC sockets, dipswitches and the headers HD1 to HD3.

Solder in all the capacitors except C27 to C47, carefully noting the polarity of C1 to C6 as you insert them. Solder in the resistor packs RP1 to RP3. If you are unable to obtain resistor packs you
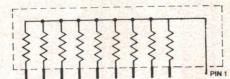
Figure 1. **The insides of a resistor pack. If a resistor pack is unavailable, individual 4k7 ¼W resistors may be substituted.**

may use nine resistors instead of each pack, as shown in Figure 1. Resistor pack orientation is important; pin 1 is indicated by a black dot.

Now solder in wire-wrap pins in the positions L1 to L3, as shown on the overlay. Finally mount and solder in the regulators IC 30 to 32, with suitable heatsinks and mounting bolts.

A close-up view of the headers on board. Headers HD1, HD2 and HD3 select the PROM type. These are configured so that both banks will contain 2708s here.

Power up

The board is ready for its first power-up. Plug it into your computer, stand back, and apply power. Check that the following voltages, with respect to ground, are present on header HD3:
a) −5 volts on pin 13
b) +5 volts on pin 14
c) +12 volts on pin 3.

Extra bypass:

You must now decide which PROM types you want to configure your ETI-682 for. The following PROMs are supported by the ETI-682:

PROM number	Size	Power supplies needed
2708	1K by 8	+5 V, +12 V and −5 V
2758	1K by 8	+5 V
2716	2K by 8	+5 V
2732	4K by 8	+5 V

If you want to use 2708s, extra bypass capacitors will be needed. These are

soldered in as follows:
1) If you want to use 2708s in bank 1, solder in C27 to C36.
2) If you want to use 2708s in bank 2, solder in C37 to C46.

Headers HD1 to HD3:

Headers HD1 to HD3 have to be strapped according to what type of PROMs you want in each bank. Header HD1 and the right half of header HD3 set the PROM type for bank 1, while header HD2 and the left half of header HD3 set the PROM type for bank 2. The four diagrams on page 105 show how to strap these headers for each of the four PROM types. For each PROM, the left diagram refers to header HD1 or HD2 and the right refers to the left or right half of header HD3, depending on which bank you are configuring.

Phantom:

This board can 'phantom out' lower priority memory if desired. If this is required, strap a wire across link L2. The board will now pull phantom low whenever an enabled PROM is read from.

Bank select:

The ETI-682 supports bank select. If you wish to bank select this board a wire should be connected between link L1 and the required bank select line on your buss. The board will now be enabled whenever this bank select line is high (3 volts or above), and will be disabled whenever it is low (0.8 volts or below).
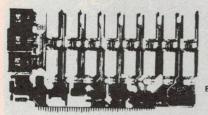
Wait states:

Some PROMs that you wish to use may have access times slower than required by your processor. If this is the case the ETI-682 may be configured to generate one or more wait states when the pro-►

NEW DESIGN

T.C.T. 64 K Dynamic Board
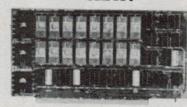
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If you think you have a good dynamic memory board, just try this quick quiz:
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Would your board work with DMA devices?

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Having designed several computers for commercial applications, and produced more than 300 boards, we decided it was time to release our dynamic memory board.
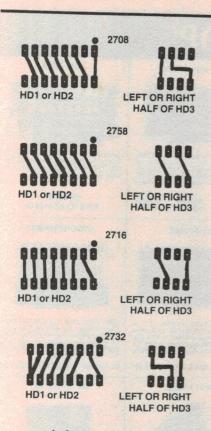
P.O. Box 263 Wahroonga, 2076, N.S.W.

Please add $10 for post and packing.
Allow two weeks for delivery, we will immediately inform of any unexpected delays.

2708
HD1 or HD2 — LEFT OR RIGHT HALF OF HD3

2758
HD1 or HD2 — LEFT OR RIGHT HALF OF HD3

2716
HD1 or HD2 — LEFT OR RIGHT HALF OF HD3

2732
HD1 or HD2 — LEFT OR RIGHT HALF OF HD3

PROM 4
PROM 5
PROM 6
PROM 7
PROM 3
PROM 2
PROM 1
PROM 0

DIPSWITCHES DS2 DS3, LAYOUT

cessor reads from an enabled PROM.

A monostable, IC13, is provided on the board for generating these wait states, in preference to using poorly defined buss signals such as phi 2 and PSYNC.

If you want to add wait states during PROM reads do the following:
1) Solder in a 1k resistor at R1.
2) Convert the desired wait state duration to nanoseconds (ns) and apply the following formula to find the required capacitor, C47, value (in pF):
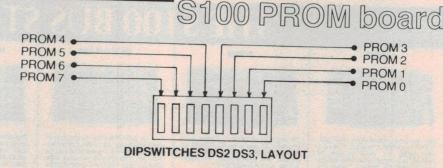
$$C47 = 1.84 \text{ x (required time)}.$$

3) Solder in this capacitor (C47).
4) Strap a wire across link L3.

Locating the banks:

Each of the two banks on the board may be independently located at any 4K boundary, no matter what size PROMs are being used in each bank. Dipswitch DS1 is used to set the start address for each bank. Switches 1 to 4 (left half) set the start address of bank 1, while switches 5 to 8 (right half) set the start address for bank 2. The layout of DS1 is shown in the diagram below:

A12
A13
A14
A15
A15
A14
A13
A12

BANK 1   BANK 2

DIPSWITCH DS1 LAYOUT
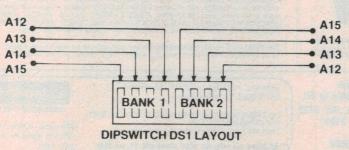
The top byte of the required start address is set up on the corresponding dipswitches (1 to 4 or 5 to 8). Note that a closed switch represents a binary one, while a binary zero is represented by an open switch. This is opposite to most addressing circuitries, such as those on the ETI-640 and ETI-681.

Where the PROMs go

All that is left is to plug in PROMs as required. The first PROM in each bank is designated PROM 0, and subsequent PROMs are numbered from 1 to 7. The table below shows the layout of these PROMs.

Chip number	PROM number	Bank number
IC14	0	1
IC15	1	1
IC16	2	1
IC17	3	1
IC18	4	1
IC19	5	1
IC20	6	1
IC21	7	1
IC22	0	2
IC23	1	2
IC24	2	2
IC25	3	2
IC26	4	2
IC27	5	2
IC28	6	2
IC29	7	2

Since you won't always have eight PROMs plugged into a bank, two dipswitches are provided for disabling PROMs. Dipswitches DS2 and DS3 are used for disabling PROMs in banks 1 and 2 respectively. The eight switches on each dipswitch correspond to each of the eight PROMs in a bank. The layouts of DS2 and DS3 are the same, and are shown in the diagram above.

A switch in the on position will enable the corresponding PROM while a switch in the off position will disable the corresponding PROM. By using these switches, any number of unused PROM sockets may be disabled to avoid wasting memory space.

In use

It's about time for an example. Imagine we wanted 12K of 2716s in bank 1 (6 PROMs) located at 1000 hex, and 7K of 2708s (in bank 2) located at D000hex. From left to right we set the dipswitches as follows:

DS1: 1 off, 2 off, 3 off and 4 on puts bank 1 at 1000 hex; 5 on, 6 on, 7 off and 8 on puts bank 2 at D000 hex.

DS2: 1 and 2 off, 3 to 8 on enables the first 6 PROMs in bank 1.

DS3: 1 off, 2 to 8 on enables all but one PROM in bank 2.

Wraparound

You probably hadn't noticed, but the ETI-682 allows you to locate large (such as 8K, 16K and 32K) blocks of memory on finer (4K) boundaries. This addressing flexibility produces an unusual side effect. If a bank is located at some high address, such as F000 hex, the first part of the bank will reside from F000 hex (say) to FFFF hex. The remainder of the bank will "wrap around", and appear from location 0 upwards.

By plugging PROMs into the appropriate sockets this wraparound effect may be used to advantage. If you wish you could have some PROMs at both high and low addresses, using only one bank. If wraparound is going to occur, and you don't want to use it, simply disable the particular PROMs with DS2 and DS3.

Finally, a note about different PROM types. A variety of ROMs are available which are pin-for-pin compatible with the corresponding PROMs. Examples include the 2308, 2316 and 2332 ROMs, which are pin-for-pin compatible with the 2708, 2716 and 2732 PROMs respectively. These ROMs would of course be directly compatible with the ETI-682. There are many other types of PROMs and ROMs and, with a little thought, many of these too could be interfaced to the ETI-682 PROM board. ●

Chess anyone ?

Back Door Into BASIC

Having examined BASIC in its 'static' form — used line by line and entered manually — Phil Cohen goes on to show how the knowledge built up by the reader so far can be used to write and understand useful programs.

Part 4
Phil Cohen

THE TIME HAS COME to get into programming proper — this month, I'll show you how to put the bits together and write a program.

In a programmable calculator, the user simply has to enter the operations (key presses) of the program in the right order, and the machine will remember them in that order and execute them on demand.

In a computer, however, where the program may be several thousand characters long, this is not feasible — the chances are that you *will* make mistakes both in designing the program, and also simply in typing it in.

For this reason (and for others, which I'll come to later), a computer program is split into 'lines' (as a poem is split into lines, with each line being as long as suits the program, rather than being the width of a page).

Each line of a BASIC program has a number. This number determines the order in which the computer will carry out the lines of the program. The number is typed in by the user, along with the line of program.

```
MEMORY

┌ ─ ─ ─ ─ ─ ─ ┐
  1 A = 5
└ ─ ─ ─ ─ ─ ─ ┘

┌ ─ ─ ─ ─ ─ ─ ┐
  2 PRINT A
└ ─ ─ ─ ─ ─ ─ ┘


┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
  SYSTEM
  PROGRAM
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
```
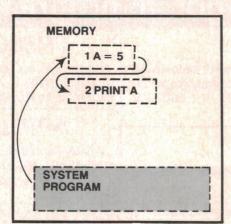
Figure 1. **This shows the organisation of the storage of a program in the computer's memory. The system part of memory need only hold a pointer to the start of the first line, as long as each line 'points' to the start of the next.**

Say the user types in: '1 A = 5', then '2 PRINT A'. The computer would store this as shown in Figure 1. Notice that the start of the program is noted in the 'system' area of memory, and that the end of each program line tells the computer where the start of the next line is.

If the user then typed in 'RUN', the computer would take this as a signal to go to the first line of the program and do what it found there. This would mean that it would look in its symbol table for A, find that it didn't exist, allocate a space for it in memory, put the value 5 into it, then come to the end of line 1.

At the end of line 1, it would find (in a form that is not visible to the user, by the way) a reference telling it the position in memory in which line 2 starts. It would then go to line 2 and 'execute' it (carry it out). This would make it take the value from A and print it.

What the user would see while this was going on would be his input of

'RUN', followed on the next line by simply '5'.

After completing the 'execution' of the program, the computer would revert to its original mode of operation, ready to take input from the user.

The program would still be there in memory, and the LIST command would allow the user to look at it.

If the user input 'LIST', the computer would reply with: '1 A = 5' followed on the next line by '2 PRINT A'.

In the above example, the numbers 1 and 2 are 'line numbers'. They are there merely to show the computer what order the lines are to be executed in.

For example, the user could have chosen 10 and 20 for the line numbers. An input of '20 PRINT A' followed by '10 A = 5' would give the same result as '1 A = 5', '2 PRINT A'. The computer would still execute the lines in the order: line 10, then line 20. When the program was LISTed, it would be listed in the order: line 10, line 20.

In fact, a program can be entered by the user in any order at all, as long as the line numbers reflect the order in which the program is to be executed.

If the user put in a line with a line number that had already been used, the computer would simply over-write the original line with the new input.

For example, if the user had entered the following program:

10 A = 5
20 PRINTTT A
30 PRINT A + 2

and he wished to correct line 20, all he would have to do would be to input '20 PRINT A'.

Notice that in this example, the line numbers are separated from each other by 10. This is done so that lines may be inserted — if the following program had been entered:

10 A = 5
20 PRINT A

and the user wanted to insert a line between lines 10 and 20 which, for example, added 2 to A, then he could input: '15 A = A + 2'. The program would then look like this:

10 A = 5
15 A = A +2
20 PRINT A

The INPUT Statement

This is all very well, and you could write programs to solve simple problems using what I have given you so far — but we've yet to cover the part of the program which gives it much of its power as a problem-solving tool. This is the INPUT statement.

Every time a program is run, an INPUT statement will ask for data — the data is then entered by the user. This means that you can 'load' a program off a cassette, then RUN it and enter the data as you go. 'Prompts' (prints) from the program can even tell you what piece of data to enter at what time.

The INPUT statement looks something like this: 'INPUT A'. When the computer comes to this part of the program, it will put a '?' on the screen, then stop. The user would then type in a number and press RETURN. The computer would put the value that the user entered into A, then continue. Let's look at a simple example:

10 PRINT "WHAT NUMBER"
20 INPUT A
30 PRINT A, "SQUARED IS", A*A

When the program is RUN, the computer will print 'WHAT NUMBER', then put a '?' on the screen (on the next line). The user would then type, say, 5, then press RETURN. The computer would reply (again on the next line) with: '5 SQUARED IS 25'. The program would then stop.

Although this is a very simple example, it shows the power of the INPUT statement coupled with explanatory PRINT statements ('prompts'). If the program had been one which determined life insurance costs from numbers representing the sex, age, marital status, packs of cigarettes a day, income, medical history . . . etc, of a particular person, then the part of the program which INPUT all of these factors (giving the user appropriate 'prompts') could very well take up more space than the equations which actually worked out the answer!

What IF?

One of the more powerful features of a computer is its capability to make decisions. It does this by means of a statement called an IF statement.

The IF statement allows you to tell the computer to do one of two things at any given point in the program, depending on the result of an equation.

The equations used in IF statements are called *relational* equations — we'll look at these a bit more closely before delving into the uses of IF.

A relational equation gives a result which has one of two values — 'True' or 'False'. For example, the relational equation $4 > 2$ will give the result 'True'.
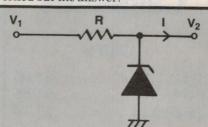
By the way, for those of you who haven't met it before, the ' $>$ ' symbol means 'bigger than'. So $4 > 2$ means '4 is bigger than 2', which is of course true. $3 > 5$ is false.

There is another related symbol, ' $<$ ', which means (you guessed it) 'littler than'. So $2 < 4$ means '2 is littler than 4', which is true.

If you find that you confuse these two symbols, it is useful to notice that, for the relational equation to be true, the number at the 'thick' end of the symbol has to be bigger than the number at the 'thin' end. That's how the symbol came about, surprise, surprise.

Okay, so we've got these 'relational' equations — what do you do with them?

Say you wanted a program which INPUT a value into variable A, then limited the value of A to a maximum of 10 and printed out the result, so that ▶


```
10 PRINT "INPUT VOLTAGE"
20 INPUT V1
30 PRINT "OUTPUT VOLTAGE"
40 INPUT V2
50 PRINT "CURRENT"
60 INPUT I
70 P2 = I * V2
80 V3 = V1 − V2
90 R = V3 / I
100 P1 = I * V3
110 PRINT "R IS", R, "OHMS,", P1, "WATTS"
120 PRINT "ZENER IS", P2, "WATTS"
```

The above program takes in data about the circuit shown and calculates the component values. The program can be split into three parts — input, processing and output. Lines 10 to 60 are input, 70 to 100 are processing and 110 and 120 are output.

A typical program run will give the following results (inputs by the user are shown in **bold** type).

```
RUN
INPUT VOLTAGE
?30
OUTPUT VOLTAGE
?20
CURRENT
?0.5
R IS 20 OHMS, 5 WATTS
ZENER IS 10 WATTS
READY
```

Notice that the computer has put 'READY' on the screen after it finished the program. This is to tell the user . . . well, that the machine is ready. If the word READY is not on the screen, then the computer must still be in the process of executing the program.

Line 80 works out the voltage drop across the resistor. This is then used both in line 90, to find the resistor value, and in line 100, to find the resistor's power dissipation. We could have missed line 80 out altogether and written line 90 as '90 R = (V1 − V2) / I' — but we need the value of V3 in line 100, too. Working it out once in line 80 saves time, because the value is used twice.

Notice that the variable names used are as far as possible 'mnemonics' for the data we're working with — R for resistor, P for power, etc. This sort of thing is part of program 'documentation' — which is like being tidy in any calculation (once you get into the habit, it saves you time in the long run).

inputting any number less than 10 would result in the number simply being printed out again, but inputting a number bigger than 10 would result in '10' being printed out.

Ideally, you want a part of the program to notice when the value of A is greater than 10, and to set A to 10 if this is so. Then if A was less than 10, the program would do nothing to it, but if A was bigger than 10 it would print out '10'. An example of a program which would do this is:

```
10 INPUT A
20 IF A > 10 THEN A = 10
30 PRINT A
```

The words IF and THEN on line 20 have the following meaning to the computer:

IF: Evaluate the relational equation which follows. It ends just before the word THEN.

THEN: If the relational equation you just worked out is True, then do the rest of this line, otherwise ignore it and go on to the next one.

If the value of A *was* bigger than 10, then at line 20 the computer would work out the result of 'A > 10' (which in this case is true), then go *through* the word THEN and execute the rest of the line — which is 'A = 10'. This will set the value of A to 10. It would then go on to do line 30.

If the value of A was *smaller* than 10, then the computer would work out the value of the relational equation 'A > 10', which would in this case be false, then come to the word THEN, ignore the rest of the line and go on to line 30.

More Complicated Relational Equations

You can get all sorts of things out of a relational equation. For example, '=' is perfectly allowable. '4 = 4' will give the result 'True', while '8 = 9' will be 'False'.

You can even combine '=' with the other two symbols, so that ' > =' means 'bigger than or equal to'. '5 > = 5' is true, '8 > = 2.2' is true, but '5 > = 123' is false.

Similarly, ' < =' means 'smaller than or equal to'.

A word of caution. Some computers will accept ' >=', but not '= > '. When all else fails, look at the manual.

Another useful symbol is '#', which means 'not equal to'. So '5 # 5' is false. Confusing, eh? I always feel it's best to stick to the simple ones.

It's quite possible to have relational equations using strings, by the way. This is useful when you want the user to input a 'yes/no' reply to a program. For example:

```
10 INPUT A
20 PRINT "DO YOU WANT TO
   PRINT A"
```


The Sorcerer — a popular computer amongst hobbyists and small business users.

```
30 INPUT A$
40 IF A$ = "YES" THEN PRINT A
```

Notice that the part of the line after the word THEN can be any sort of statement.

As with any other BASIC statement, it's quite possible to have a relational equation which compares the results of two other equations:

```
10 INPUT A
20 IF A*A = 3*3 THEN PRINT "A IS
   EITHER 3 OR −3"
```

You can even have relational equations which combine the results of other relational equations.

```
10 INPUT A
20 IF A*A = 3*3 AND A > 0 THEN
   PRINT "A IS DEFINITELY 3"
```

In the above example, the word AND combines the results of 'A*A = 3*3' with 'A > 0'. If both of them are true, then the result of 'A*A = 3*3 AND A < 0' will be true. If either of them are false, then the result will be false.

Other words which operate in a similar way to AND in BASIC are OR and NOT. OR is an easy one, and needs no explanation (although I'll define how it works later).

NOT is a bit like a minus sign in front of a number — it doesn't need two values to work with, only one. 'NOT 1 = 1' will be false, but 'NOT 2 = 1' will be true. So the following will work:

```
10 INPUT A
20 IF NOT A = 10 THEN PRINT "A
```

IS NOT EQUAL TO 10"

```
30 IF NOT A = 10 AND NOT A = 20
   THEN PRINT "A IS NOT EQUAL
   TO 10, NOR TO 20"
```

The following table gives a definition of how AND, OR and NOT work. Letters a and b are used to describe the two relational equations:

a	b	a AND b	a OR b	NOT a
true	true	true	true	false
false	true	false	true	true
true	false	false	true	false
false	false	false	true	true

Applications of Relational Equations

Relational equations are useful in a variety of places, but especially (in the sort of programming we're dealing with) right at the start of the program, where the data is being fed in. For example, in a program which works out square roots, the number which is fed in can be checked to see that it is greater than zero — if it is not, then trying to find the square root of it could cause the computer to abort the program and print out an error message.

```
10 INPUT A
20 IF A > 0 THEN PRINT SQRT(A)
```

Notice that the result of '0 > 0' is false. '0 > = 0' is true, however.

PEEK and POKE

These rather cute-sounding BASIC words allow the user to access the ▶

computer's memory directly — as the computer itself does — rather than indirectly through the use of variables.

A typical 'picture' of the contents of the computer's memory is shown in Figure 1. The user has influenced the contents of the memory by inputting a simple program. All of the 'management' of the computer memory — where to store the program, which part of memory to use as system memory — has been handled automatically by the computer. In fact, the program in ROM which tells the computer how to be BASIC tells it how to manage the memory (see part 1).

PEEK and POKE allow the user to override the computer's memory management — PEEK allows the user to find out what is stored in a particular part of memory, and POKE allows him to insert a new value into it.

Computer memory size is usually of the order of 10 to 50 thousand 'locations', each of which will hold approximately one character (I'll expand on that later). These memory locations are numbered from zero (usually) in sequence — 0, 1, 2, . . .

9997, 9998, 9999, 10 000, etc.

PEEK is rather like a scientific function (see part 2), in that 'A = PEEK(44)' will set the variable A to the value stored in location 44. This value will be a whole number somewhere in the range 0 to 255.

I said earlier that this was approximately one character's worth — well, if you call letter A character 0, letter B character 1, . . . letter Z character 25, then you still have little letters (a, b, c . . . z), which take you up to 51, and then numbers 0, 1, . . . 9, which makes 61, then all sorts of punctuation marks and some special characters only used in computers — well, you can quickly make up a total of very nearly 255. So each memory location can really only mean one character. You can't squeeze more than one into a single location, if you want to have the full range of characters available.

I've explained how PEEK works — how about POKE? This is a bit more complicated. It needs a line of program to itself. For example, 'POKE 345, 22' will put the value 22 into location 345.

Like many other BASIC functions,

you can use equations rather than fixed values for PEEK and POKE. Like 'C = PEEK(A*3)', or 'POKE A*2, 4/B'.

This is all very well — but what use are they? Well, there are two main uses for PEEK and POKE. The first is to allow the user to influence or monitor the operation of the computer's automatic processes. For example, if you happen to know (and the user's manual you get with the computer will usually tell you) the location at which the computer stores its symbol table (i.e: that part of system memory which holds the names of all of the variables used by the program), then you can print out all of the variable names you have used in a particular program. This is useful — especially in a long program, where there is a danger of using the same variable name for two purposes by mistake.

Another use for PEEK and POKE is to use the computer's memory for specific purposes which the computer doesn't cater for. For example, say you wanted to store 1000 whole numbers, each with a value between 1 and 100. If you tried to do this in BASIC, each

---

An Introduction To Syntax Definition

This bit might be a little heavy for some people — I've included it for interest's sake, but if you can't get the hang of it, feel free to ignore it, as it's not required knowledge for the rest of the series.

I've shown that, in many cases, not only can BASIC functions be used with fixed values — for example SIN(4) — they can also be used with almost any equation in place of that fixed value — SIN(A*A).

In order that language designers — those people who write compilers and interpreters — can handle the multitude of possible forms that can occur, a method for describing computer syntax has been developed.

It's called the 'syntax diagram' (no great surprises there) and it's based on the technique of

defining things a little bit at a time. As an example, I'll define the syntax of a BASIC equation. First, the fundamentals:

    letter = A|B|C ... |Z
    number = 0|1|2 ... |9
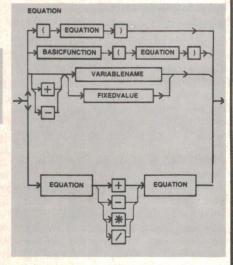
The "|" symbol means 'or', so that the first line defines 'letter' as being A or B or ... or Z. So every time from here on in that we use the word 'letter', we mean any one letter from A to Z. So 'letter letter' could be any of 'AB', 'KF', 'RP', etc. Notice that this definition of 'letter letter' does not allow a space between the letters. If we had wanted a space, we would have used 'letter space letter'.

The second line above defines 'number' in much the same way.

Now for arithmetic variable names (i.e: not strings):
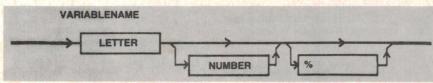
The diagram at the bottom of the previous column is a definition of a fixed value (such as −3 or 5.678), excluding the possibility of exponents for simplicity. The 'backwards' arrows around the two 'number' boxes indicate that 'number' can be repeated any number of times in this part of the syntax.

The definition of 'equation' is really sneaky — it uses the word 'equation' as part of its own definition! This means that, anywhere the word 'equation' appears in the definition, any of the other possible results of the diagram may be substituted. I hope that a good long look at the following diagram will make things clear:

VARIABLENAME

The diagram above works something like a flowchart. You start at the left and take any route to the right, but always following the arrows. At a branch, you can take any of the possible routes, depending on which of the possible syntax results you wish to get.
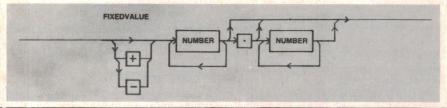
The diagram defines 'variablename' as being one letter, followed by an optional number, followed by an optional '%' (for an integer variable). There are 4 possible results of this:

    letter
    letter number
    letter %

letter number %

The last two are integer variables (like 'A%' or 'B7%').

Now let's try to define an equation:— a series of BASIC words and other things which can be 'evaluated' by the computer to give a numerical result (again, for simplicity, ignoring the possibility of string variables — which you can incorporate yourself for practice). We'll start with the names of BASIC functions:

    basicfunction = ABS|SIN|COS ... |PEEK

Rather than try to list them all, the above definition merely points to a set of function names.

EQUATION

As I said at the start of this section, some people might find this a little difficult to digest. It's really only useful when you come to learn a second or third computer language — it provides a method of handling syntax, and will allow you to crystallise your knowledge of the language for easy reference. Many people (myself included) also find it fascinating in itself.

How about trying to define the syntax of the English language?

FIXEDVALUE

number may take up several locations in memory. This is because when you ask the computer to allocate space for a variable, it has no way of knowing the maximum value that variable can take — and so it allocates more space than you would normally use.

Using PEEK and POKE, however, you can put the 1000 values into exactly 1000 locations.

The only problem with this sort of thing is that you stand a chance of interfering with the normal operation of the computer — if you started to put some of your variables into the area of memory where the computer has stored your program, for example, this would certainly muck things up!

For this reason, it is usual to set aside an area where the computer is not allowed, except by the use of PEEK and POKE. Some computers (the Apple, for example) allow the user to define the upper and lower limits of the memory available for BASIC operation (except by the use of PEEK and POKE). As long as the *user* ensures that he only uses PEEK and POKE *outside* that area, all will be well. Figure 2 shows the sort of thing I mean.
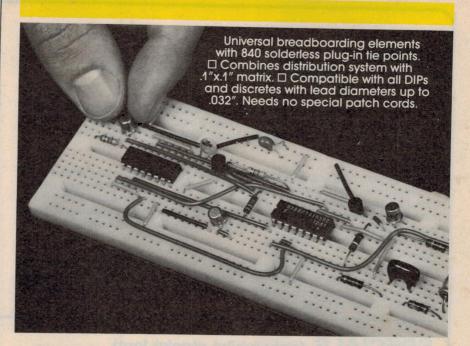
Figure 2. **This is the sort of memory usage which is allowed in systems where the BASIC area may be defined by the user. Notice the much smaller area needed to store '1' by the use of PEEK/POKE, compared to normal variable storage.**

PEEK and POKE are really not the sort of thing that a first-time user will get involved with — after you have bought a computer, and become completely familiar with the operation of it in BASIC (which usually takes about a month of late nights, and sometimes a divorce or two — it's very addictive), then the use of PEEK and POKE can expand the capabilities of the machine you are using, and also enable you to explore in detail how the machine operates internally.

NEWS

John F Rose Computer Services Pty Ltd have added 3 new models to their OPAL range of Computers:

System 1

This is a 27 megabyte winchester S-100 computer system featuring 128K RAM, 2 x 8" double density double sided disk drives, 2 serial RS232C ports for terminals and 1 Centronics parallel port suitable for the NDK S-4000 printer. The operating system is MP/M.

System 2

This system is based around a 10 megabyte SA1004 winchester disk drive with 1 x 8" Shugart disk drive running CP/M 2.2 and CP/NET. Up to 4 terminals can be slaved off each master system. The terminals are equipped with a Z80 CPU to handle screen control and a pair of 8085/8088 CPU's for main processing and high speed DMA data transfer with the master system. The master systems can be linked to form a larger network.

System 3

This system is an extension of the well proven OPAL 1000C system. The system boasts 2 x double density double sided disk drives (total capacity 2.2 megabytes) with greatly enhanced performance by virtue of DMA transfers from disks. The operating system is CP/M 2.2.

SPECIALS (only whilst stocks last)

16K S-100 IEEE California Computer Products Static RAM Boards. Full 4 Mhz operation with no wait states. Bank selectable on 4k Boundaries, 4k blocks can be addressed anywhere in 64k in 4k increments. Fully buffered. LED's for board and bank selection. Fully assembled and tested with 90 day warranty on a bring-in basis.

PRICE $300.00 plus $56.00 sales tax. (15 only)

MPI model 88T printer. Upper lower case, 132 columns, takes 8.5" tractor feed (or smaller paper), expanded and condensed print, 120 characters per second. 30 day warranty on a bring-in basis.

PRICE $600.00 plus $90.00 sales tax. (2 only)

Seattle 8086 S-100 CPU board with S-100 memory support board, 8086 Assembler and BASIC-86 (by Microsoft). Tested and works okay.

PRICE $800.00 plus $120.00 sales tax. (1 only)

16K memory expansion kits for the Apple II computer.

PRICE $40.00 plus $6.00 sales tax. (2 off)

CP/M 1.4 for the TRS-80 with disk drives.

PRICE $130.00 (10 off)

CP/M 1.4 for the Sorcerer with disk drives.

PRICE $130.00 (12 off)

Send $1.00 for our hardware catalogue and to be included on our mailing list.

LIFELINES

Lifelines is a monthly software newsletter published by Lifeboat Associates. Although Lifelines contains features and columns dealing with new software products on the market, product comparisons, the CP/M Users Group and other items of general interest, the principal role of the periodical is to provide timely notice to owners about their software. Each month, new revisions are reported, together with information on the purpose for each such release, be it for the correction of "bugs" or the addition of features and facilities.

The software products distributed by Lifeboat Associates are frequently both complex and costly. We recommend that all serious users of software should take out subscriptions to Lifelines, ensuring that they are automatically informed about the current state of their software tools and thus get full value for their purchase.

Subscription Costs: $36.00 for 12 issues. Price includes postage for anywhere in Australia. $5.00 each for back issues. Price includes postage for anywhere in Australia.

All orders must be prepaid. Write to:

John F. Rose Computer Services Pty. Ltd.,
P.O. Box 745, Crows Nest, 2065.

NDK S-4000

MATHEMATICS SAMPLE USING STANDARD CHARACTERS

$$F(\omega) = aT \frac{\sin \omega T/2}{\omega T/2} e^{-j\omega T/2}$$

$$e_{RMS} = \sqrt{4KTR(f_2 - f_1)}$$

$$L_1 = 10 \log \frac{1}{80} \times S_m \text{ (dB)}$$

$$A^2 + B^2 = C^2$$

$$H_2SO_4 \qquad H_2O$$

$$W_{xy}(f) = \int_{-\infty}^{\infty} \psi_{xy}(\tau) e^{-j2\pi f\tau} d\tau$$

$$L = \int_0^{\pi} \sqrt{\left(\frac{dx_1}{d\theta}\right)^2 + \left(\frac{dy_1}{d\theta}\right)^2} d\theta$$

$$\psi_{xy}(f) = \tan^{-1}\left[\frac{P_{xy}(f)}{C_{xy}(f)}\right]$$

$$\left.\begin{array}{l} a_1x + b_1y = c_1 \\ a_2x + b_2y = c_2 \end{array}\right\}$$

$$x = \begin{vmatrix} c_1 & b_1 \\ c_2 & b_2 \end{vmatrix} \div \begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix} = \frac{c_1b_2 - c_2b_1}{a_1b_2 - a_2b_1}$$

$$S = \sum_{j=1}^{n} X_j$$

$$\Delta f_{max} \tau_{max} \leq 0.3$$

$$\left| W_{xy}(f) \right| = \sqrt{C^2_{xy}(f) + Q^2_{xy}(f)}$$

$$\Psi_{xy}(\tau) = \lim_{T \to \infty} \frac{1}{T} \int_0^{T} f_x(t) f_y(t+\tau) dt$$

BSTAM

BSTAM is a commercially orientated telecommunications facility for transmitting and receiving CP/M files over telephone lines. Files may be sent between two CP/M computers using a short wire.

BSTAM will transmit and receive any CP/M file. There is no limit on the size of the file. In addition to this, all data is transmitted exactly as it is stored on disk. For example, if a byte of data is X'FF', it is sent as 1 byte and not as 2 ASCII F's. By doing this, data is transmitted at maximum line speed.

BSTAM includes the following features:

1. ERROR CHECKING
   Framing Errors
   Overrun Errors
   Parity Errors
   BCC Errors (Block Control Check — CRC type)
   Auto Block Resend
   Mid Block resend
   Length Errors
   Lost data errors
   Exception errors
   Time out errors
   BCB errors (Block control Byte Counter)
2. GROUP FILE TRANSMISSION AND RECEPTION
   Transmit A:*.*
   Transmit B:*.BAS
   Receive A:
   Receive B:

3. USER INTERFACE FOR UART/USART CHIP.

Hardware and Software requirements
- 16k RAM
- 1 disk drive
- 1CRT (running at least 4800 baud)
- CPU 8080/Z80 or 8085
- Asynchronous modem that will support at least 300 baud:
  Full duplex option
  Originate or Answer option
  RS-232 option
- SIO interface (UART/USART chip)
  300 baud strapping
  Header strapped at terminal end
- CP/M or some derivative
- RECEIVE.COM (BSTAM)
- TRANSMIT.COM (BSTAM)

On short wire connections, the baud rate may be set at 9600 baud.

New Features
The new version of BSTAM is 4.4. This version has a new extended receive mode. In this mode BSTAM will wait to receive more files until a Control C is entered on the receiving console. In addition, BSTAM has much better recovery features when data errors are detected.

PRICE $150.00

BSTMS

BSTMS was designed for the use of CP/M computers to connect the host computer (IBM, Honeywell, Univac etc.) for time sharing. BSTMS is a high level TTY emulator. The main difference between BSTMS and a real TTY is it's ability to send and receive files. As you know, a human operator cannot enter data at 30 chrs/sec. This is what BSTMS does very nicely. Also BSTMS can echo all Host input to your list device.

BSTMS is divided into separate parts. First there is the terminal mode and second the file mode. The terminal mode is used to run your CP/M computer as is it was a TTY. While in the terminal mode, you may change between half and full duplex at any time just by keying a command to BSTMS. After doing whatever you have to do in CP/M, you may return to BSTMS and start off in the host computer. Also BSTMS has been connected to all types of CBBS's and ABB's. BSTMS may also connect to another CP/M as its host computer.

While BSTMS is in file mode, you may send or receive a file to the host computer. When sending a file, BSTMS will expand all Control I's into multiple spaces to align on columns of 8. BSTMS may also transmit binary files. There are two programs used to send and receive binary files. The first is DCOMPRES.COM. This program will convert any binary file into an ASCII file. The second program is COMPRES.COM. This program will convert any DCOMPRESsed file into a binary file.

The minimum requirements in the computer hardware and software are:

1. CP/M operating system or compatible
2. 24k user memory space when transmitting a file. All received files must fit into the available memory. (see BSTAM).
3. 1 disk drive
4. 1 CRT running at least 4800 baud.
5. CPU: Z80, 8080, 8085
6. Asynchronous modem that will support at least 300 baud.

   a. Full duplex option
   b. Originate option
   c. RS-232 option
7. SIO Interface — Any USART/UART chip
   a. 300 baud strapping
   b. Header strapped at terminal end
8. Installation of BSTMS may require knowledge of assembler language programming. Installed using the same technique as BSTAM.

New version with better features just released.

PRICE $200.00

Quality ★ ★ ★ ★

Price ★

Those who believe that a one star price will invariably dictate a similar result have obviously still to experience the union of Traminer and Rhine Riesling. **McWILLIAM'S**

SOUND

Suction platters, laser light shows, PCM and sigma drive — at the All Japan Audio Show, 1980.

Unquestionably, Australia's audio market is dominated by Japanese products. The All Japan Audio Show is where the companies try out their new developments. Dennis Lingane reports on the 1980 show — maybe we'll see some of that fancy gear here, soon.

The race is on with digital audio. Although the Digital Audio Disc Standardisation Committee is supposed to be deciding between the 250 mm AHD disc and Philips' Compact disc, the majority of manufacturers appear to have already made up their minds.

The PCM Compact Digital disc players were everywhere. Each and every hi-fi manufacturer worth his salt was demonstrating a prototype. Early 1982 is the date tipped for the launch of this new sound scene.

That serious note apart, the hi-fi show is just as mind-boggling an experience as the electronics show (see News Digest, lead story). Here, all the manufacturers try out new prototypes on the public — all 360 000 of them over the four days the Show ran!

At times it was impossible to move in either of the two halls. You were simply carried along by the crowd — especially on Saturday and Sunday.

The Japanese certainly take their audio seriously. Even a typhoon that poured tons of water on Tokyo on opening day couldn't keep the thousands of enthusiastic fans away.

I was fascinated by the army of girls who were supposed to be dressed seductively walking around in boots, mini skirts and tights, handing out metal flowers. To this day that is one tradition that baffles me.

They didn't rate a second glance from the Japanese men. Not on your nelly. Their total concentration was fixed on the new electronic wonders due for 1981 release — 'new wave' items like the JVC turntable which has a suction system to hold the record flat on the platter.

Extensive demonstrations were done to 'prove' that this four kilogram suction force not only ironed out any warps in the record but improved the sound as well.

Up the road from JVC, National had thousands queuing to listen to its PCM cassette deck that is due to go into production in April this year and which will sell for around $2000.

It uses a VHS tape and is ideal for the audio buff who wants to be ahead of the Joneses. Technics say it will produce a thousand a month.

Technics also released a range of straight-line tracking turntables to back up its top-line SL10. A survey taken at the show the previous year showed that 60% of the buying public would rather have straight-line ▶

PCM is the coming thing! And nobody wants to miss out, though different manufacturers are taking a punt on particular systems. This is Hitachi's digital disc player employing Philips' Compact Disc system. Software factories are being set up *now*.

Matsushita, never a company to be left behind, showed this new Technics PCM cassette recorder. Due for release in April, it fascinated everyone — including this attractive young lady who later admitted she didn't have a clue what PCM meant!

tracking turntables if they could afford it.

Say no more — the Japanese are about to make sure they can afford it, so get ready for a flood of straight-line tracking turntables.

On the amplifier front there are more new circuit trickery ideas being launched this year than ever before. Most, says our Learned Editor Roger Harrison, are old hat.

He seems to think that the Japanese engineers dust off old text books occasionally and resurrect some of those ancient principles that have long been forgotten.

He is obviously right (after all, he is the editor), but the unsuspecting public doesn't realise in all the razzamatazz publicity surrounding these new products that they are old principles re-born.

Anyway, get ready for 'Super Feed Forward', 'Positive Feed Forward', 'Linear Feed Forward', 'X-power' amps, 'Sigma Drive' speaker interfaces and 'Clean Drive'.

Circuitry that will keep the buffs arguing for months.

The X-power amplifiers (where did they get **that** term?) are interesting. Clearly following the lead established in the US by Bob Carver's 'magnetic power' amp, the concept is to provide big power (like 200 W) in a small, low-weight box that stays cool while delivering the goods. Yamaha's B6 model achieves this with a 'new triac circuit', but we won't know more until it appears over the horizon.
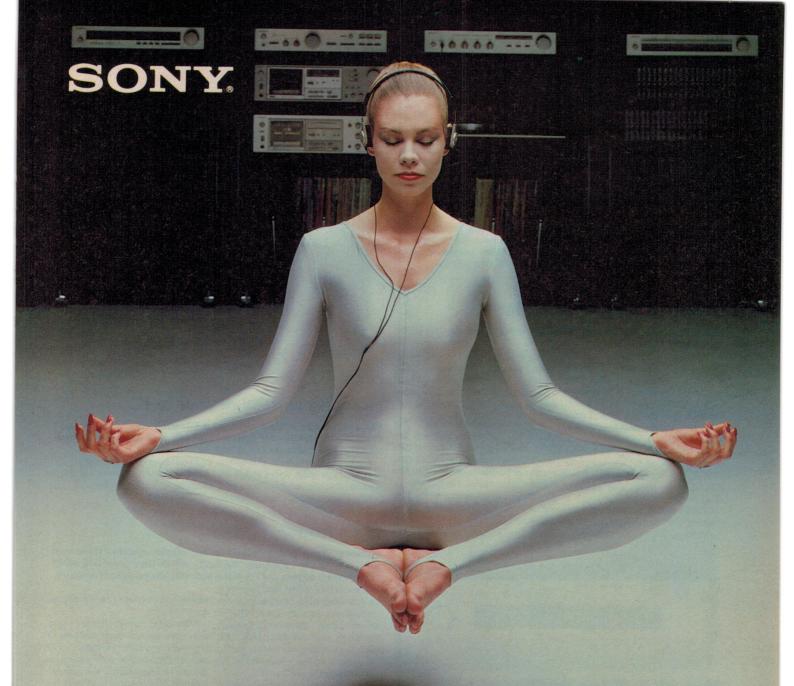
For those who like their records clean . . . one company introduced a spray-on-peel-off cleaner. You spray this stuff on your filthy records, watch while it turns to plastic and then peel it off like a Helena Rubenstein face mask. Get rid of that dust, dirt, grease and acne from your records!

NEC had the latest in home entertainment. A screen displayed two laser beams (one green, one red) which danced in time to music either from the hi-fi system or an organ. After that, what could come as an encore?

Dennis Lingane

Suck it and see. JVC's new turntable employs suction to hold the record on the platter, removing any warps. They say it improves the sound, cancels resonances and other noise.

Yamaha's latest model — on the left, the amplifier I mean! This tiny thing is a 200 W 'X-power' amp, would you believe.

The latest in home entertainment. The NEC stand featured this coloured laser light show, displayed on a rear projection screen, and driven by the organ played by the unimpressed lady at the right.

Du Pont and Philips join forces

The Du Pont company and N.V. Philips of the Netherlands have jointly formed a new company to manufacture and sell magnetic tapes and cassette products worldwide — a market that is estimated to reach $4 to $5 billion annually by 1985.

The new venture will be called PD Magnetics B.V., and will combine Du Pont's experience in magnetic and chemical technology with Philips' skills in engineering and marketing of consumer electronic and magnetic tape products.

Initial production of PD Magnetics' tape products will begin shortly at a Philips manufacturing site in Oosterhout, the Netherlands, which will be purchased from Philips by the joint venture.

Sanyo tuner and amplifier

Sanyo Australia has recently released several new models in its component hi-fi range.
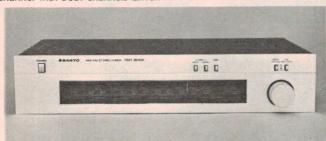
The FMT 3510K is an AM/FM tuner which has been styled to match Sanyo's DCA 3510 integrated amplifier. It features a slim, brushed silver front panel. Controls are positive push-button type, and station selection is easy with the large tuning knob.

The DCA 3510 integrated amplifier has been styled to match the FMT 3510K tuner, with the same slim control panel and brushed silver finish.
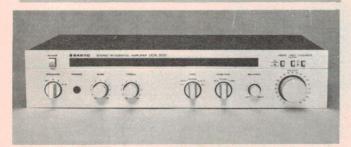
Output power is 40 W RMS per channel with both channels driven over the range of 20 Hz to 20 kHz. Total harmonic distortion at rated power is no greater than 0.1%. A headphone socket is fitted, together with provision for tape dubbing.

Recommended retail price for the DCA 3510 is $239 and for the FMT 3510K tuner $199, and the two will be available from selected audio specialists from February. For further information contact Mr. G. Boucher, Sanyo Australia Pty Ltd, 225 Miller St, North Sydney 2060. (02)436-1122.

Housing worthy of your hi-fi . . .

Chadwick's new cabinet modules will improve the appearance of even the cheapest hi-fi system, and will present a really good-looking, expensive system at its best.

Each module comes with either twin or single glass doors and fixed shelves, and the variety of sizes and finishes is bound to include one to fit into your listening area.

For more information on these modules, contact Chadwick on (02)647-1103.

Eyes front?

National have just released a car stereo system, somewhat enthusiastically called the 'Cockpit', which they claim will make "the interior of your car . . . just a little like the cockpit of a plane".

Should this design feature appeal to you, National's compact system comprising cassette deck, AM/FM stereo tuner, three-band graphic equaliser and pre-amp built into your car's ceiling will enable you to "just reach up like a pilot and all the sounds you like are there".

The 'console', as National call it, measures 708 mm x 219 mm x 68 mm, and has a 46 W maximum output stereo power amp which can operate through a two or four-speaker system. Controls are said to be "touch control" so as not to distract the driver's attention from the road — but he still has to know which 'touch control' he's pressing, doesn't he?

National's press release also describes various other controls to regulate the graphic equaliser, tuner and cassette player, so if you see a driver coming towards you with his steering all over the road and his face turned anxiously to the ceiling of his car, you'll know what the problem is.

Full details on turning your car into a cockpit are obtainable from your local National Panasonic dealer or from P.O. Box 319, North Ryde NSW 2113.

Speaker responses — correction

In last month's issue we introduced the new technique now being employed by Louis Challis to evaluate loudspeakers. We wish to correct a nomenclature error in reference to the speaker response plots.

The plots produced by Laurie Fincham of KEF are correctly called "cumulative decay response" plots, while those produced by Louis Challis' technique are more correctly called "spectral decay" plots. Thanks to Louis Challis for advising the correction.

Peerless polypropylene pips paper

Peerless of Denmark's new range of high-powered woofers uses a polymer material developed in their Copenhagen laboratories as a loudspeaker membrane.

They claim that these membranes offer high tensile strength, low mass, high temperature stability and high internal damping, and that when compared to ordinary paper cones the 'Peercone' exhibits better reproduction consistency, greater environmental stability and better resistance to mechanical abuse.

Early experiments indicated that a loudspeaker cone made from polypropylene, although low in mass, had excellent strength to withstand high piston type stress without break-up, bass response therefore being reproduced accurately and solidly. Its internal damping enables the upper frequency response (above-piston band) to be reproduced with exceptional smoothness and clarity. It is not possible with conventional cone material to obtain this optimum performance in both frequency regions without cone impregnations, secondary applications of damping material, etc. which add mass and, often, inconsistencies.

The new "Peercone" driver exhibits very smooth response curves and well controlled high frequency roll-off. Each driver employs a closed-cell foam surround termination which has been mass loaded and viscous-damped to reduce high Q resonances, which add distortion and colouration to above-piston frequencies.

A new flat spider is also being used on the 'Peercone' drivers. This spider, which has progressive stiffness characteristics, secures a more graduated braking with big amplitudes, resulting in lower distortion at large cone excursions, according to Peerless.

When auditioned on any programme material the 'Peercone' drivers are reported to perform exceptionally well, drawing remarks such as 'sweet', 'clear', 'crisp' from the listeners.

The range being produced consists of 120 mm, 160 mm, 200 mm, 250 mm, and 300 mm drivers. The low frequency parameters and sensitivity have been optimised to achieve excellent bass response with good sensitivity.

All 'Peercone' drivers employ high temperature voice coils for high power handling and durability, and utilise sensible winding widths for stability at low frequencies and low harmonic distortion.

For further information on the 'Peercone' drivers and the full range of Peerless loudspeakers, contact G.R.D. Group Pty Ltd, 698 Burke Road, Camberwell Vic. Phone (03) 82-1256. The 'Peercone' woofers are expected to be available in Australia from February 1981.

Never play alone again!

You will never have to play out of time any more, either! Both problems are defeated by a neat little instrument just released by Tandy Electronics . . . the Concertmate Electronic Accompanist/Metronome.

Gone forever are the days of pendulum-type metronomes that marked musical time with a monotonous "tick . . . tick . . . tick". Realistic's new Concertmate adds to the versatility and the enjoyment of both practice and performance, and allows the musician to enjoy making music solo or with others.

As an accompanist, it has five rhythm keys which can be combined into eight distinctive rhythms. You can choose from Latin, Bossa, Rock, Foxtrot and Waltz, or select combinations of each such as Bossa/Rock and Waltz/Rock. The rhythm speed can be adjusted with the easy-slide tempo control.

Concertmate is designed to provide the sounds of five musical instruments: bass drum, clave, cymbal, snare drum and highhat.

All you have to do is make the appropriate adjustments and let it work.

As a metronome, the Concertmate offers controllable sound level, tempo and LED indication.

Concertmate features a built-in speaker, triple-time (six steps) and quadruple-time (eight steps). You can use its battery-operated internal system or play through your audio system, and you can also utilise optional equipment such as an external speaker and foot switch. 280 x 70 x 200 mm, the unit requires six "C" batteries, ac adaptor or dc auto adaptor (not included).

The Concertmate is available from Tandy Electronics stores and participating dealers across Australia (cat. no. 42-2103), and costs $89.95.

The tranny lives again!

Remember the Fifties, when the transistor radio was the latest electronic wonder and everyone between the ages of twelve and twenty went nowhere without his tranny, his earpiece, and a vacant, twitching expression?

Well, now you can do the same with FM radio, should the urge grab you.

The FM Stereo Boy is a miniature, ultra-lightweight FM stereo receiver with featherlight headphones. With the receiver clipped to your belt and the headphones clamped over your ears, you can have music (FM stereo at that) wherever you go.

The FM Stereo Boy retails for $89.95, and is distributed in Australia by Digidal Pty Ltd, Suite 1903, Plaza Tower, 500 Oxford St, Bondi Junction NSW 2022. (02) 387-5786.

New car speakers from Sanyo

Sanyo has released six new models in its range of car speakers to accompany its already well-established AM/FM combination radio/tape players and car stereo tape decks.

The new speaker range features acoustically transparent, open mesh grilles, higher power handling capacity, and a greater emphasis on two and three-way systems. All the multi-way systems are suitable for bi-amplification.

Sanyo claims to have a car speaker system to suit every car and budget. All models have been designed to ensure long-term reliability and smooth, distortion-free performance. Prices start as low as $27.00 rrp.

For further information contact Mr. G. Boucher, Sanyo Australia Pty Ltd, 225 Miller St, North Sydney 2060. (02) 436-1122.

RARE ADDITIONS FROM MARANTZ.
SUPERIOR FM TUNERS.

Rāre: very valuable.
Addi'tions: the things added.
Ma'rāntz: a range of ultra-high performance FM Tuners which blend state-of-the-art engineering with operational versatility.

The name Marantz guarantees your choice from a superior range of AM/FM Stereo Tuners, guarantees exceptional quality and, with the advent of more FM stations, Marantz guarantees your total listening pleasure.

MARANTZ ST500
AM/FM STEREO COMPUTUNER

Sleek, slimline and microprocessor controlled — tune and recall stations with amazing speed and precision. The Computuner features state-of-the-art, quartz-locked, drift free frequency synthesised tuning with 7AM and 7FM memory presets. The LED signal strength display doubles as a multipath indicator and the Wide and Narrow IF Selector enables the switching of a tuning bandwidth best suited to reception area conditions.

MARANTZ ST600
AM/FM STEREO TUNER

This model incorporates a built-in oscilloscope that affords the most precise means possible to determine optimum reception, even from weak or distant stations. The functions of the oscilloscope extend well beyond those of conventional tuner meters.

MARANTZ ST400
AM/FM STEREO TUNER

A large, fuss-free Vacuum Fluorescent readout clearly displays the selected frequency and Electronic Gyro-Touch with Servo-Lock guarantees drift-free, razor-sharp tuning every time. Uncompromising quality through and through.

MARANTZ ST300
AM/FM STEREO TUNER

Consistent with all quality Marantz tuners, the ST300 features MOSFET FM front end and Phase Lock Loop demodulator for superlative performance — low distortion, extremely linear operation and wide dynamic range. Illuminated dial cursor, LED function indicators and Gyro-Touch tuning make the ST300 an exceptionally sophisticated buy at a modest price.

Your Marantz stockist will be pleased to demonstrate the complete range of Marantz tuners. If you see your hi-fi as an investment and, if you demand critical performance standards as well as the best value for money, listen to the future.
Listen to Marantz.

marantz
Now you're listening.

Loudspeakers in the round

The familiar square or rectangular box housing for loudspeakers is being attacked from all sides these days, it seems. While unorthodox shapes have yet to become the norm, they could have their merits. Our UK correspondent, Brian Dance, examines here some recent circular designs from JR Loudspeakers.

JR LOUDSPEAKERS LTD introduced the JR149 circular loudspeaker about four years ago. Designed for power levels of about 60 W, it gave excellent reproduction in the limited space of a domestic environment. Although the JR150 is only slightly larger than the JR149, it is claimed to have improved sensitivity, a better polar response and an improved transient performance — and a 100 W programme handling capacity. The JR149 will still be available for less ambitious hi-fi enthusiasts at around two-thirds of the price of the JR150.

Circular construction

The most unusual feature of both the JR149 and the JR150 is their circular construction, which gives them a very distinctive appearance no matter whether the speakers sit on the floor or the optional JR149 wall bracket is used to hang them on a wall without undesired vibrations. Both models have

been designed by Jim Rogers, a director of the firm, whose object was to produce a small unit with outstanding reproduction and good low bass.

Why did he choose a circular speaker design? Most speakers are enclosed in rectangular boxes, but the resonances of such boxes pose many problems in spite of the use of damping material and internal partitions. When a circular construction is employed, the diffraction effects of the more familiar rectangular enclosures, which produce an uneven polar response, are avoided. In addition, some people may prefer the look and the relatively small size of the circular speakers.

The basic design of the JR150 is essentially similar to that of the JR149, namely an aluminium cylinder with a section cut off along a chord to produce a flat front. The speaker units are mounted on this flat plate (a pair of KEF B110 bass and mid-range radiators and a soft-domed tweeter). A

curved metal grill protects the radiating units and renders the cross-section of the speaker a true circle. The top and bottom of each unit is closed by dished metal end caps, concave outwards, which provide strength and also spread the vertical resonances over a wider frequency range. The JR150 has a 38 mm diameter aluminium bar fixed between the end caps, the magnets of the bass units being compressed against this bar through pads of foam to reduce resonances.

The two bass units are connected electrically in parallel and are also effectively in parallel from the acoustical point of view; this is said to reduce distortion and improve efficiency. The crossover unit is mounted on a printed circuit board recessed into the concave bottom cap. The 16-element filter produces a slope of 24 dB per octave. A slide switch marked 0 dB and −2 dB is fitted on to the printed circuit board to provide either a flat response under anechoic

SPECIFICATIONS

	JR 149		JR 150
Frequency Response:	40 Hz - 40 kHz	Frequency Response:	40 Hz - 40 kHz
Power Handling:	60 watts programme. Suitable for 20 - 100 watt amplifier	Power Handling:	100 watts programme. Suitable for amplifiers from 15 to 100 watts
Sensitivity:	83 dB ref. 1 watt into 8 ohms	Sensitivity:	87 dB ref. 1 watt into 8 ohms
Impedance:	Suitable for outputs of 4 - 16 ohms	Impedance:	Suitable for outputs of 4 - 16 ohms
Crossover Frequency:	3 kHz	Crossover Frequency:	2.2 kHz 24 dB per octave
System Resonance:	59 Hz	System Resonance:	65 Hz critically damped
Dimensions:	9" dia (23 cm) x 14⅝"	Dimensions:	21" H x 11" Dia (55 cm x 28 cm)
Weight:	12 lb (5.5 kg)	Weight:	24¾ lb (11 kg)
Bass Unit:	13 cm (Long throw)	Bass Unit:	2 x 13 cm (Long throw)
Treble Unit:	2 cm Dome	Treble Unit:	1 x 2.5 cm (Soft Dome)

Table 1: JR 149 and JR 150 specifications

Frequency response curves for the JR149 are shown in Figure 1, using a microphone placed at the standard distance of one metre from the axis of the tweeter (although this is very different from the normal listening position). The curves show that both the on-axis response and the response at 30° off-axis from the tweeter are relatively smooth. (Only the high frequency response is affected by directional characteristics of the loudspeakers). Room characteristics affect the lower bass response of the curves. Pink noise tests have shown that very little 'colouration' is present.

JR Super Woofer

The response of the JR149 and JR150 units inevitably falls off at very low bass frequencies, since it requires a large unit to provide appreciable power at very low frequencies. JR have therefore recently introduced a special "Super Woofer" circular loudspeaker as an add-on unit to their speaker system to handle very low frequencies from 30 Hz to 120 Hz. Although the Super Woofer is of much larger diameter and is heavier than the JR150, only one Super Woofer is required in a stereo system and it can be placed anywhere in the room, since very low bass frequencies carry no directional information.

JR have introduced a special low pass amplifier (LPA) for use with their Super Woofer. This amplifier unit receives the complete stereo signal from the amplifier outputs and passes it unaltered to the two speakers which cover the middle and top frequencies. The signal at frequencies below about 70 Hz is filtered off and passed to a separate amplifier where it is processed into an amplifier signal for the Super Woofer. ▶

From left to right: the earlier JR149, the new JR150 and the tiny 'Metro' speakers discussed here.

conditions or a slight high-frequency roll off from the tweeter which gradually increases to 2 dB to reduce 'presence'. The crossover filter board also contains a 2.5 A fuse to protect the tweeter, together with a spare fuse — the latter can be most helpful!

Both the JR149 and the JR150 are available in various wood and leather finished tops, aluminium or anodised gold, as well as red, green or brown leather inlaid into rosewood.

Performance

The specifications of the JR149 and JR150 loudspeakers are shown in Table 1. However, readers will appreciate that what really counts is not a set of performance figures, but rather the results of prolonged listening tests in a certain type of room. Such listening tests certainly show these circular speakers to be excellent, but each individual must decide for himself whether they meet his particular requirements.
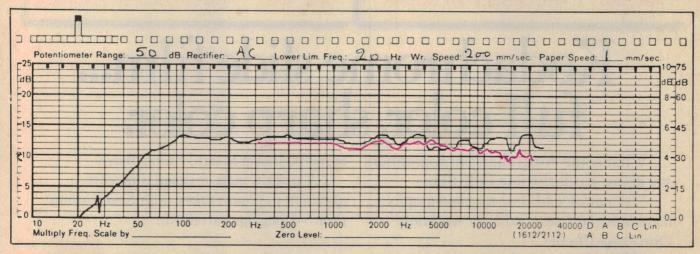

Figure 1. JR 149 response curves. Black curve on axis of tweeter at one metre. Red curve 30° off axis of tweeter at one metre. Measured using gating technique. (From JR Loudspeakers Ltd).

Sooner or later you'll need a Gregory's.
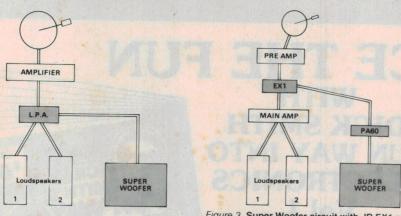
Figure 2. Connection of Super Woofer in system with low pass amplifier.

Figure 3. Super Woofer circuit with JR EX1 crossover unit and PA60 monaural amp for extreme bass frequencies.

JR's electronic crossover unit for use with the Super Woofer

The extreme bass is not removed from the signals passed to the regular speakers. The Super Woofer in this type of system is connected as in Figure 2.

Another type of Super Woofer basic circuit is shown in Figure 3, in which the JR EX1 electronic crossover unit is used together with a separate PA60 monaural amplifier for the extreme bass frequencies. In this system only frequencies greater than 70 Hz or 100 Hz (according to the setting of a panel switch) are passed to the regular speakers; these speakers can handle more power than when they receive very low frequency signals as well as the frequencies they are required to reproduce.

If the 70 Hz level is selected, there is no detectable direction of the very low bass frequencies. If, however, very small speakers are being used, it may be preferable to use the 100 Hz position to prevent possible overloading of the small speakers. In either position, the filter response provides an 18 dB per octave characteristic. The bass lift control provides a flat response or a lift of 3 dB or 6 dB at 25 Hz.

The specifications of the Super Woofer unit are given in Table 2. In listening tests the unit can be expected to greatly improve systems with loudspeakers of a limited size when deep organ music or similar material is being played. However, the use of the Super Woofer will also bring out any traces of hum or turntable rumble which may not have been previously noticeable. The Super Woofer system can also be used to augment the bass from some electrostatic loudspeakers.

Metro

JR also market a speaker known as the Metro which is especially small for a unit with a 60 W programme handling capability. The specification is shown in Table 3, but unlike the other speakers from this manufacturer, the Metro is rectangular in shape.

JR loudspeakers are produced in St Albans, England.

NOTE: The Australian agents for JR Loudspeakers Pty Ltd are International Dynamics, P.O. Box 205, Cheltenham Vic 3192. (03)95-0366.

Frequency range:	extending down to 30 Hz approx.
Power handling capacity:	100 watts programme.
Impedance:	Nominally 8 ohms at 120 Hz.
System resonance:	42 Hz.
Dimensions:	20 in diameter (51 cm) 18½ in high (47 cm)
Weight:	38.5 lbs (17.5 kg).
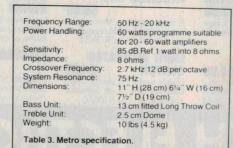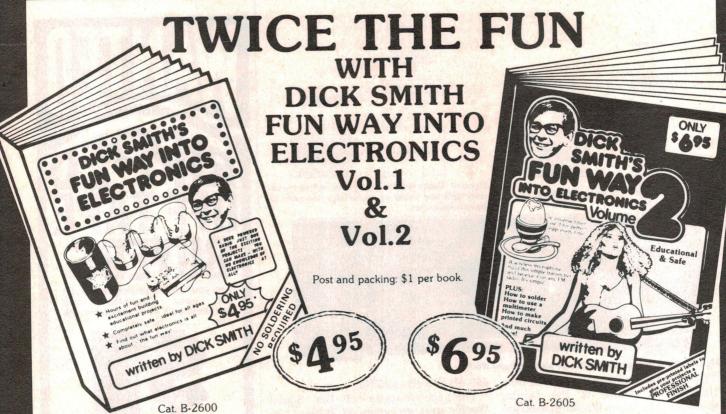
Table 2: Super Woofer specification

Frequency Range:	50 Hz - 20 kHz
Power Handling:	60 watts programme suitable for 20 - 60 watt amplifiers
Sensitivity:	85 dB Ref 1 watt into 8 ohms
Impedance:	8 ohms
Crossover Frequency:	2.7 kHz 12 dB per octave
System Resonance:	75 Hz
Dimensions:	11'' H (28 cm) 6¼'' W (16 cm) 7½'' D (19 cm)
Bass Unit:	13 cm fitted Long Throw Coil
Treble Unit:	2.5 cm Dome
Weight:	10 lbs (4.5 kg)

Table 3. Metro specification.

Technics RS-M51 cassette recorder — new features plus good performance

Technics' new cassette deck offers excellent value for money, and according to Louis Challis its performance is as good as all but the fanatic could desire as well as offering a few new features that outclass those of many other models.

Louis Challis

IT SEEMS that nowadays there are two distinct market segments for cassette recorders: the basic no-frill machine on the one hand, and the increasing number of more complicated products aimed at the person prepared (or able) to spend a little more on their hi-fi equipment on the other. Manufacturers in this last range obviously try to provide a range of options in their products that surpasses their competitors, and the

Technics' RS-M51 cassette deck does have some new features which many other companies have not yet managed to provide.

Features
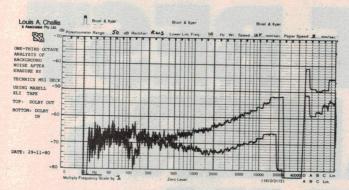
The RS-M51 has a particularly attractive appearance, and at the same time shows a number of practical innovations in design philosophy.
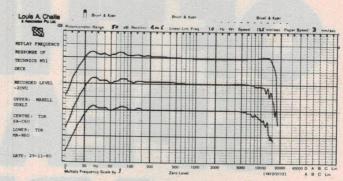
There is an 'auto record' function for

adjusting the level setting on both channels as well as an auto tape selector system to detect and accommodate the use of any type of tape.

On the left side of the unit is the normal pneumatically damped cassette well with a clear front, overlying a row of soft touch switches which provide the usual functions of eject, record, rewind, reverse, fast forward, cue, play, stop and pause. The most significant difference

Louis A. Challis & Associates Pty. Ltd. — ONE-THIRD OCTAVE ANALYSIS OF BACKGROUND NOISE AFTER ERASURE BY TECHNICS M51 DECK USING MAXELL XLI TAPE. TOP: DOLBY OUT. BOTTOM: DOLBY IN. DATE: 29-11-80

Louis A. Challis & Associates Pty. Ltd. — REPLAY FREQUENCY RESPONSE OF TECHNICS M51 DECK. RECORDED LEVEL -20VU. UPPER: MAXELL UDXLT. CENTRE: TDK SA-C60. LOWER: TDK MA-R60. DATE: 29-11-80

between the controls on this deck and those on other decks is that it is only necessary to touch the record button to go into the record mode; there is no need to simultaneously activate the play button.

In the centre of the deck beside the tape well is a three-digit counter, below which are four illuminated bezel lights. These indicate the automatic selection of normal gamma ferric oxide, chromium dioxide, metal or ferri-chrome tapes. The selection for automatic or manual is controlled by a switch on the back which has three switch positions of auto, and two manual positions for metal and ferri-chrome tapes.

Below the illuminated bezels the de-signers have incorporated a record mute button. When pressed this removes the clicks of a stylus falling onto a record or a commercial in a radio or TV pro-gramme whilst the tape mechanism is still running.

On the right hand side of the front panel is a set of illuminated displays on a grey panel with white engraving, be-hind a piece of recessed glass. Starting at the left, there are three bezel lights to indicate the selection of the recording mode, Dolby noise reduction, and inputs from the two microphone channels being activated. To the right of these is an array of 16 light-emitting diodes in a ramped display, indicating which level of the recording level sensor readout has been activated. This indicates the setting of the electronically controlled attenuators incorporated within the deck, which replace the normal slide or rotary attenuator controls found in other equipment.

Obviously it is not enough to provide the automatic level setting function alone and the system is supplemented by a 'rocker bar' control underneath the display for adjusting the attenuation range up and down at will. The actual setting chosen is then displayed by the incremental movements of the illumi-nated light-emitting diodes, and constitutes a very sensible display system.

Adjacent to the level sensor readout display is a dual function plasma display which utilises white plasma bars in groups of three for −20 to zero VU and yellow displays from 0 VU to +8 VU. As well as displaying the normal peak VU settings, which are a tremendous advance on the old VU meters with their inexorably inaccurate ▶

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MEASURED PERFORMANCE OF TECHNICS M51 CASSETTE RECORDER

RECORD TO REPLAY FREQUENCY RESPONSE AT - 20VU:

TAPE	DOLBY	LOWER -3dB POINT	MAX. POINT AND FREQUENCY		UPPER -3dB POINT
MAXELL XLI	OUT	27Hz	0.5dB	10kHz	16kHz
MAXELL XLI	IN	25Hz	1.3dB	5kHz	15kHz
TECHNICS XA	OUT	25Hz	0.5dB	25kHz	16kHz
SONY Fe - Cr	OUT	26Hz	0.5dB	15kHz	17kHz
TECHNICS MX	OUT	27Hz	0.5dB	23kHz	17kHz

SPEED ACCURACY: + 1%

WOW AND FLUTTER:

WOW:	Average	0.2 %	P-P
FLUTTER:	Unweighted	0.12%	RMS
	Weighted	0.04%	RMS

SIGNAL TO NOISE RATIO:	49dB(A)	Without Dolby
	59dB(A)	With Dolby

response to detecting peak programme content, the displays incorporate a second function. This takes the form of displaying the highest peak signal recorded during the previous two seconds of programme content, with continual automatic resetting.

When using the deck in the recording mode it is necessary to touch the large 'auto record' sensor bar on the lower right face of the deck (below the illuminated display) to initiate this automatic function. During the next seven seconds the internal electronic circuitry samples the music or programme content to detect the peak level and thereafter sets the level of the electronic attenuator to provide what is described as 'optimum level adjustment'. The actual position selected in the overall attenuator range is indicated by one of the 16 bars on the level sensor readout display already referred to. Whilst this is happening the auto

record sensor bar is flashing red; as soon as it has set the display it changes to a steady green.

The rear facilities on the deck include an output level control, a socket for a remote control pause and record mute capability, two pairs of coaxial line sockets for inputs and outputs, and the tape selector switch for auto/manual setting as discussed above.

The tape deck case is a well-designed and fabricated plastic moulding, featuring an aluminium extrusion for the front section and a painted steel lid and steel panel base to improve its immunity to stray magnetic leakage flux from other components stacked above or below.
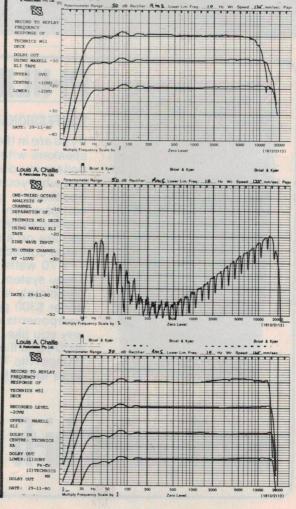
The inside of the unit is typical of the latest generation of advanced cassette recorders, with large printed circuit boards comprising excellent component coding and good layout. The lower board features the conventional amplifiers
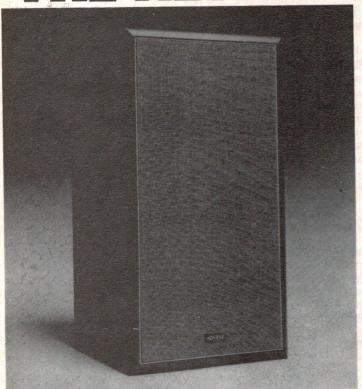
and circuit controls and functions. A large and somewhat different additional board surmounts the main board. This contains the 16 dual-in-line integrated circuits for the automatic level control, whilst two supplementary boards provide the plasma display control functions and the left channel/right channel pre-amplifier functions.

The main deck capstan drive and motor mechanism is well made and features plastic and metal components incorporated into a moulded monolithic structure which itself forms part of the main deck housing. Unlike some other machines from Technics (and other manufacturers), this unit incorporates a much larger number of wiring harnesses with a far greater number of wires than we would have expected. These have been lightly laced in a manner which is not typical of current Japanese manufacture. These harnesses make effective use of plugs and ▶

E74

HARMONIC DISTORTION:

TAPE: MAXELL XLI

		100Hz	1kHz	6.3kHz
OVU:	2nd	-49.2	-59.3	-47.9 dB
	3rd	-53.0	-47.1	-41.0 dB
	4th	-55.2	-59.0	-62.2 dB
	5th	-54.8	-64.1	- dB
	T.H.D.	0.48	0.48	0.98 %
-6VU:	2nd	-	-	- dB
	3rd	54.2	-55.5	-55.8 dB
	4th	-	-63.0	- dB
	5th	-	-	- dB
	T.H.D.	0.19	0.18	0.16 %

MAXIMUM INPUT LEVEL: (for 3% third harmonic distortion at 1kHz)

TAPE: MAXELL XLI   + 8 VU

DYNAMIC RANGE:

TAPE: MAXELL XLI

Dolby Out	53 dB(Lin)	57dB(A)
Dolby In	62 dB(Lin)	67dB(A)

ERASURE RATIO:

(for 1kHz signal recorded at OVU)

TAPE:	MAXELL	> 90 dB
TAPE:	TECHNICS RT-60 MX	> 90 dB

DATED: 29-11-80

Louis A. Challis & Associates Pty. Ltd.
RECORD TO REPLAY FREQUENCY RESPONSE OF TECHNICS M51 DECK DOLBY OUT USING MAXELL XLI TAPE. UPPER: OVU CENTRE: -10VU LOWER: -20VU DATE: 29-11-80

Louis A. Challis & Associates Pty. Ltd.
ONE-THIRD OCTAVE ANALYSIS OF CHANNEL SEPARATION OF TECHNICS M51 DECK USING MAXELL XLI TAPE. SINE WAVE INPUT TO OTHER CHANNEL AT -10VU DATE: 29-11-80

Louis A. Challis & Associates Pty. Ltd.
RECORD TO REPLAY FREQUENCY RESPONSE OF TECHNICS M51 DECK RECORDED LEVEL -20VU UPPER: MAXELL XLI DOLBY IN CENTRE: TECHNICS XA DOLBY OUT LOWER: (1) SONY Fe-Cr (2) TECHNICS MX DOLBY OUT DATE: 29-11-80

sockets so that the individual printed circuit cards are easily removable.

On test

The objective testing of the unit quickly showed that the performance of the unit was every bit as good as the manufacturer's literature claimed. In particular, the replay response of the unit using our standard test tapes proved to be remarkably smooth, extending from below 20 Hz to 15 kHz with Maxell UDXL1, to at least 14 kHz with TDK-SA and to beyond 10 kHz with metal tape. Obviously the differences in frequency response on the replay tests come as a result of the small differences in azimuth alignment between the reference machine used to produce the test tapes and this particular machine. Nevertheless the performance is particularly good and undoubtedly a credit to the machine design.

The record to replay test results are not quite as good at the very lowest frequencies, as the results only extend down to 25 Hz at the −3 dB point. Conversely they are much better at the top end. Thus by way of reference, the −20 VU results with Maxell XL1 are 15 kHz, with Technics XA 16 kHz, with Sony Ferri chrome 17 kHz, and with Technics MX (their new metal tape) also 17 kHz. More importantly, all of these results are achieved with a remarkably flat response which is reminiscent of the best of the reel to reel recorders or the best of the other cassette recorders that we have recently reviewed.

The other important parameters including wow and flutter are also particularly good, with the average wow being 0.2% peak to peak and the weighted flutter being only 0.04% RMS. The speed accuracy of the unit was 1% high, which is acceptable, whilst the signal to noise ratio with Dolby-in was a very healthy 67 dB(A). This comes in part as a result of the +8 VU signal level that the unit can cope with before it produces 3% third harmonic distortion.

If the dynamic range is good, the distortion figures are generally even better, with total harmonic distortion levels of less than 1% at zero VU and less than 0.2% at −6 VU. The erasure ratio of the machine is equally commendable, being better than 90 dB for both the Maxell XL1 and Technics RT60MX tapes at 1 kHz.

In practical use the auto record sensor capability of this machine offers both advantages and disadvantages. On much of the programme content with which the machine was evaluated, it coped fairly well with the full dynamic range of the material presented and was generally within one or at most two notches on the level sensor display compared with my own choice of optimal settings. By contrast, with some records containing soft opening passages followed by violent crescendos, the results were obviously inappropriate and manual adjustment was required. It was easily possible to utilise the rocker bar control under such conditions and almost without exception the final results were remarkably good.

This manual level input adjusting capability is in many respects superior to the normal level of volume controls of other decks, and this is one feature that I would put in the 'perfect cassette recorder' that manufacturers dream of building.

The feature of a single push button for selecting the record mode proved itself very positively to be a definite plus, with few real problems in the practical situation. Given a choice of the single control versus the more conventional dual button control, the single control wins almost every time.

If I was impressed with the ergonomic and technical features of the RS-M51 recorder I was equally impressed by the quality of sound that it produced. Whilst the frequency response generally extended to 15 or 16 kHz, and there are machines which go much higher, I believe that most people do not need the extended response, and there is little or no programme content in their houses, let alone suitable speakers, to warrant any better. Whilst I initially held the view that the auto record sensor function was primarily a gimmick, practical use in the home has modified my outlook.

The RS-M51 offers exceptional and unusual capabilities which have much more going for them than may appear at first sight. It provides above-average performance by simplifying many of the tasks that other machines complicate unnecessarily, and is certainly worth consideration if it is within your price range.   ●

Dimensions:	437 mm wide x 119 mm high x 270 mm deep
Weight:	6 kg
Manufactured by:	Matsushita Electric, Osaka, Japan.
Price:	$449
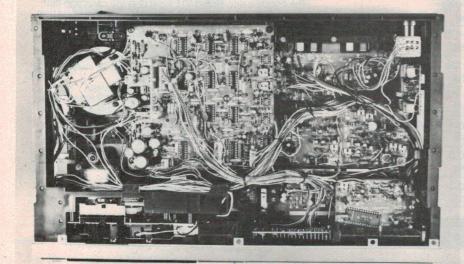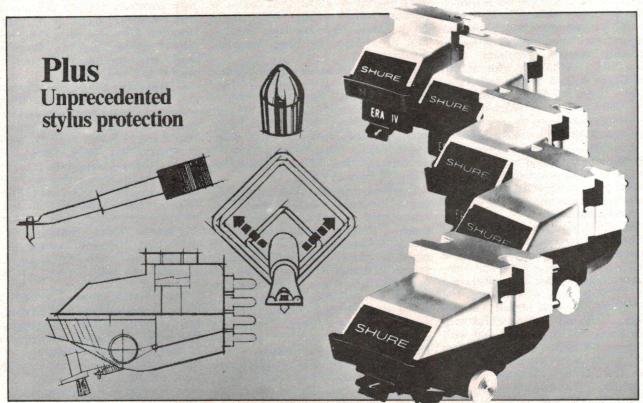
The RS-M51 cassette deck is distributed by National-Technics, P.O. Box 319, North Ryde NSW 2113.

Inside, the RS-M51 is typical of the latest generation of advanced cassette recorders. This machine makes use of a much larger number of wiring harnesses, with many more wires, than we're used to seeing. Construction quality is good and all cables interconnect via plugs and sockets making boards easily removable for service.

fact: five new Shure Cartridges feature the technological breakthroughs of the V15 Type IV

Plus
Unprecedented stylus protection

the M97 Era IV Series phono cartridges

Model	Stylus Configuration	Tip Tracking Force	Applications
M97HE	Nude Hyperelliptical	¾ to 1½ grams	Highest fidelity where light tracking forces are essential.
M97ED	Nude Biradial (Elliptical)	¾ to 1½ grams	
M97GD	Nude Spherical	¾ to 1½ grams	
M97EJ	Biradial (Elliptical)	1½ to 3 grams	Where slightly heavier tracking forces are required.
M97B	Spherical	1½ to 3 grams	
78 rpm Stylus for all M97's	Biradial (Elliptical)	1½ to 3 grams	For 78 rpm records.

Shure has written a new chapter in the history of affordable hi-fi by making the space-age technological breakthroughs of the incomparable V15 Type IV available in a *complete line* of high-performance, moderately-priced cartridges: the M97 Era IV Series Phono Cartridges, available with five different interchangeable stylus configurations to fit every system and every budget.

The critically acclaimed V15 Type IV is the cartridge that astonished audiophiles with such vanguard features as the Dynamic Stabilizer—which simultaneously overcomes record-warp caused problems, provides electrostatic neutralization of the record surface, and effectively removes dust and lint from the record—and, the unique telescoped stylus assembly which results in lower effective stylus mass and dramatically improved trackability.

Each of these features...and more...has been incorporated in the five cartridges in the M97 Series—there is even an M97 cartridge that offers the low distortion Hyperelliptical stylus! What's more, every M97 cartridge features a unique lateral deflection assembly, called the SIDE-GUARD, which responds to side thrusts on the stylus by withdrawing the entire stylus shank and tip safely into the stylus housing before it can bend.

**NEW! M97 Series Era IV Phono Cartridges...
Five new invitations to the new era in hi-fi.**

SHURE

HAWKINS AE 155 FP

Headphone amplifier

THIS SIMPLE amplifier will drive a pair of stereo headphones, and can take its input from either a tuner or cassette deck. It has the advantage of being small, completely self contained, and very portable.

This circuit gives the usual tone, balance, and volume control facilities and has plenty of drive. Ideally the unit should be used with phones having an impedance of a few hundred ohms, and most good quality types fall into this category. It also seems to work perfectly well with inexpensive 8 ohm types.

The circuit shown here is for one channel, all the components being duplicated in the other channel except for S1, RV4 and the battery, which are obviously common to both channels. The volume, treble and bass controls are all dual-gang types.
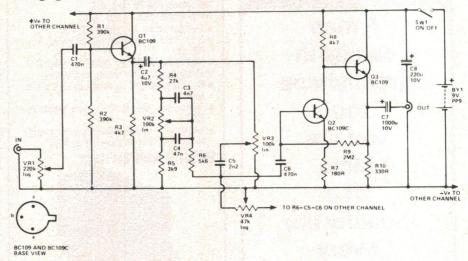
The input signal is applied to volume control RV1, and from here it is coupled to a buffer stage, Q1, giving a reasonably high input impedance, at least 100 k. It feeds a conventional passive tone control circuit that can give bass

lift or cut using RV2, and treble control using RV3. RV4 is a balance control.

The output from the tone controls is coupled by C6 to a two-stage direct coupled amplifier. This uses Q2 in the common emitter mode to give sufficient voltage gain for an output level of up to about 2 V RMS from most sources. Q3 is an emitter follower which matches the output from Q2 to the relatively low impedance of the headphones.

The unit has a total current consumption (both channels) of about 30 mA.

The Optonica RP7100 — a new concept in turntable convenience

The microprocessor now brings to turntable technology the same automatic track-finding feature as has recently been introduced in several cassette decks. Louis Challis reviews the Optonica RP7100 turntable.

Louis Challis

THE ADVENT of the microprocessor and its acceptance by the electronics industry is now already well understood by most audiophiles. Cassette and tape recorders, timers, and various types of remote controls already make full and effective use of their potential. However, one area where they have been slow in penetrating has been in the field of record players.
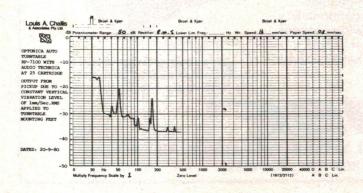
Optonica were amongst the first to use microprocessors with their APSS in the RT7100 and RT9100 electronic tape recorders. With the ground thus broken, it is not surprising that the same concept should be used in the form of the APLD (auto programme locating device) in the RP7100 turntable. The APLD system is designed to locate one out of up to seven tracks on a record and to skip over those tracks which precede it. The basic idea is that the record player should be able to select a given track on a record and play that track without the need for the user to manually cue the tone arm to find it.
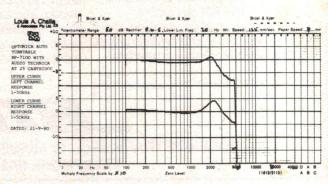
The concept of electronic searching for a programme on a cassette tape is now well accepted; using the breaks between individual tracks in recording it is possible to look for the lack of any recorded signal or alternatively to insert an infrasonic tone on the tape which is then detected by special circuitry. Obviously with records one cannot emulate this process and so Optonica came up with an entirely different approach. It seemed illogical to use the stylus and cartridge as the detection mechanism and the logical solution was to incorporate an optical system which scans the record and in doing so finds the plain sections between individual tracks.
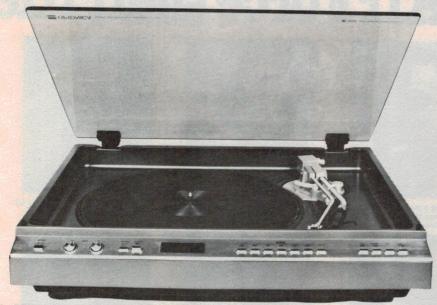
In order not to further compromise the tone arm's performance this scanning is achieved through the use of a completely separate arm from the normal tone arm. This is positioned parallel to the tone arm but is longer and somewhat different in its general appearance. It is arranged so that an infrared photosensor is positioned at its end in line with the stylus assembly of the normal tone arm. On detecting either the lead-in track or any specified track nominated, the APLD device lowers the tone arm in the correct position.

The RP7100H stereo turntable has a somewhat unfamiliar appearance. The first significant difference is the use of a glass top instead of the conventional acrylic or polycarbonate cover incorporated by most other record players. This sheet of glass has significant mass and consequently requires fairly solid spring-loaded hinges. The sheet of glass is flat, whilst the base and plinth of the turntable are moulded into a well-like structure in which the turntable and tone arm are recessed. This plinth is fairly lightly constructed, being an injection-moulded plastic structure designed for ease of fabrication and automatic production.

The front of the turntable features a sloping, brushed satin aluminium escutcheon plate on which all the controls are laid out in a linear array. These are from left to right: the power switch, two knurled rotary knobs for setting the fine pitch of the record player drive at 33 and at 45 rpm, a speed selector switch (with up setting of 33 and down setting of 45), and a quartz crystal, phase-locked loop on/off circuit control switch. When activated this either locks the motor drive circuit on to the internal crystal-

The RP7100H has a glass top rather than the conventional acrylic or polycarbonate covers. All controls are accessible with the lid down.

controlled circuit or allows the user to vary the speed with the two controls. At the front centre of the turntable is a large stroboscope window with which the speed stability of the platter in the variable speed mode can be assessed. On the right hand side of the escutcheon and immediately in front of the tone arm assembly are seven numbered push buttons. By selecting one of these the required track on a record may be selected.

On the right hand side of the plinth are four push buttons. The first of these is a "cueing" button by which the tone arm may be automatically lifted off the record. By pressing the switch a second time the tone arm will be lowered to return to the same place on the record.

Adjacent to this is the "repeat" button, which if pressed whilst a record is playing allows the record to play automatically a second time from the beginning. If the repeat button is simultaneously pressed with the play button at the start of play, then the record plays through repeatedly. To cancel the replay function it is necessary to press the "cut" button, which will terminate the sequence.

The last and most important control is the "play" button, which lifts the tone arm and places it on the first lead-in groove of the record. The tone arm is equipped with a conventional rectangular balance weight, providing adjustment in the range of 0.25 to 3 g. This is supplemented by an anti-skate adjustment which also covers the same range of adjustment. The tracking weight is normally left to the recommendation of the cartridge manufacturer. For our evaluation the Optonica distributors chose an Audio-Technica AT25 cartridge, which is Audio Technica's top-of-the-line

moving magnet unit.
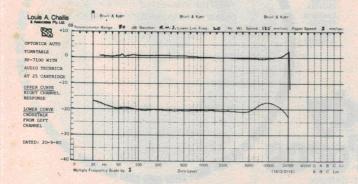
Optonica's design philosophy is in general terms very different to that of the other record player manufacturers on the market. They have designed this unit to provide the simplest possible usage with the minimum number of possible system adjustments. This is achieved through the use of their activated controls, which perform tasks other record players cannot do.
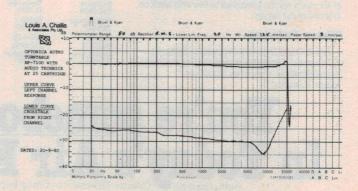
To minimise the feedback problem on what is already a very lightly constructed turntable plinth, they have combined rubber with coil springs in the adjustable isolators to reduce feedback from the supporting structure on which the turntable may be resting. To allow the user freedom of selection in terms of both cartridge and head shell, they have provided a very light and simple universal head shell assembly into which the user-selected cartridge may be screwed.

On test

The objective testing of this particular record player was a pleasant task. The AT25 cartridge that was provided with the unit for its evaluation provided truly impeccable performance. It has a particularly flat frequency response from 20 Hz to 19 kHz, with a slight rise in response at 20 kHz. The cartridge channel separation was typically 20 dB right across the spectrum for the right channel and typically better than 25 dB for the left channel. Based on our previous evaluation of our test records, the frequency response is most probably much flatter than indicated by our level recordings.

More significantly, the tracking ability of the cartridge was quite exceptional, with the cartridge faithfully tracking at all levels on the Shure test record TTR103 with a tracking ▶

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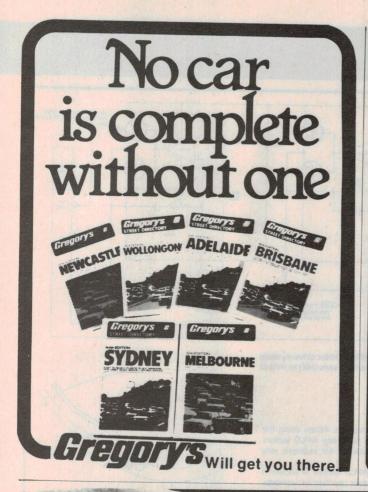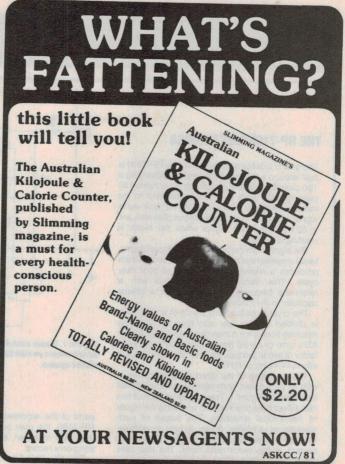
Date of Birth: ...... / ...... / ......

RG 381 FP 110 ET

RG.381.FP.110.ET

Figure 1. **Basic circuit of the motor drive system which employs Hall Effect sensors (HE) to detect motor speed.**

THE RP-7100 ELECTRONICS

The quartz locked motor system of the RP-7100 is built around a frequency generator, comprising a 160-pole magnet and a multigap head having 80 pairs of pole teeth and coils, connected to the motor, which generates a 44.44 Hz sine wave signal when the motor is rotating at 33⅓ rpm and a 60 Hz sine wave signal when the motor is rotating at 45 rpm.

The signal from the generator is fed to an operational amplifier and then to an astable circuit which produces a rectangular waveform of 50% duty cycle. This frequency is compared with a reference frequency generated from a crystal oscillator in the following way.

The crystal oscillator frequency of 9.3312 MHz is divided first by four and then by 972. The resulting frequency is then divided by either 27 (for 33⅓ rpm) or by 20 (for 45 rpm) and finally by a factor of two to produce the reference frequency of either 44.44 Hz or 60 Hz.

The operation of the direct drive motor circuit with its Hall Effect commutating devices is well illustrated in Figure 1. The outputs of each of two Hall Effect cells (marked HE) are fed to the inputs of operational amplifiers. The output of each operational amplifier drives a pair of complementary transistors which in turn control the current in the motor drive coils. The Hall cells detect the position of the rotor magnets and cause the currents in the motor drive coils to be phased accordingly. In addition, the voltage applied across the Hall cells is controlled by the servo phase control circuits and alters the switching times of the motor drive coil current so that the motor rotates at the desired speed.

The automatic programme locate device (APLD) is carried on an arm separate from the tone arm, as shown in Figure 2, so that it does not alter the stylus force. This device utilises the difference in the reflection factor for infra-red radiation of sound modulated grooves and unmodulated grooves to detect the spaces between
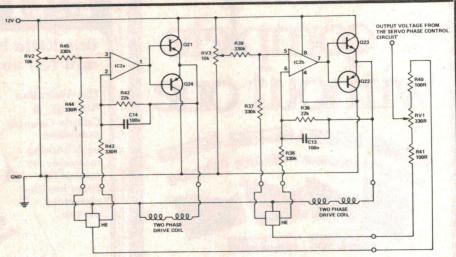
parts of the recorded material. When using the RP-7100, the user can push any APLD button, from one to seven, to select, for example, any song on a record.

The circuitry of the APLD sensor is shown in Figure 3. When the sensor reaches an unmodulated groove, positive-going pulses of some 20 to 40 mV in amplitude appear at the collector of the sensor device. This is amplified to a level of 1 V to 3 V by the operational amplifier whose output is at B. The second amplifier shapes the pulses into square waves of 7 V amplitude at point C, after which they are differentiated by C221 and R264 to form sharp pulses, which are used to trigger the monostable circuit of Q215 and Q216. The output pulses from this circuit are of constant amplitude and duration and are fed to the logic circuitry of this record player.
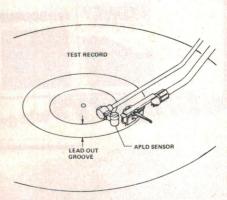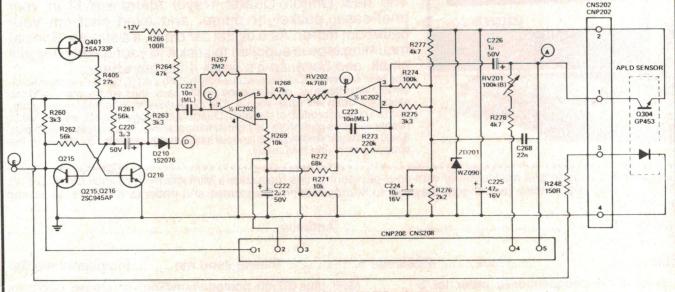
Figure 2. **The APLD sensor system employs infra-red light reflection to detect the difference between the modulated grooves and unmodulated between-track grooves. The sensor is mounted on the separate arm adjacent to the tone arm.**

Figure 3. **Basic circuitry of the APLD sensor system.**

mass of 1¼ g. The cartridge was still achieving very acceptable levels of intermodulation distortion at 30 cm/sec tracking velocity — but so much for the cartridge.

We evaluated the tone arm resonance, which occurs at approximately 6 Hz with a fairly sharp "Q" and a trace of jitter which I suspect was due to mechanical interaction with the adjacent photo-optical arm. The actual resonance frequency occurs at a lower frequency than the latest theory would dictate; this could result in some nasty problems if one were to try to play a moderately warped record. Optonica, however, do not recommend playing badly warped records with this unit and are careful to highlight this in their handbook. The shaker test of the complete turntable showed up the effects of using a lightly constructed plastic plinth with low mass and low damping.

The plinth exhibits a number of significant resonances between 20 and 26 Hz as well as at 52 Hz and at 150 Hz. The light construction of the plinth is however compensated for in part by the efficacy of the spring and rubber mounting feet and by the added mass of the glass top. The other features of the unit including the wow and flutter are acceptable and the speed stability is excellent.

The subjective evaluation of this unit was particularly interesting. This is one of the first of a new breed of record players designed for the person who wishes to be able to play his or her records in the most flexible manner possible and with the least complication. I noted that whilst the Auto Programme Locate Device worked well on the whole, on some records it cued into the second groove rather than at the very start of the recording as intended.

The ability of the player to be able to cue to any track on the record is a positive and distinct advantage for any user, and provided this is achieved without compromising the other important operational parameters, then the results justify the means. With any cartridge offering the characteristics and attributes of the AT25, the results are worth the trouble, and it becomes possible to identify the functional and design factors which could be improved in subsequent generations of this record player.

It is clear that the RP7100H has lost some of the ruggedness and technical panache as a result of the incorporation of the APLD function. Nevertheless, it could be said that the differences between this record player and conventional manually operated record players are analogous to the differences between a manual transmission car and automatic transmission car. Obviously both camps have their adherents, and judging by the number of automatic cars on the road, many people gladly sacrifice some areas of performance in favour of ease of operation and labour-saving.

My own impression of the RP7100 stereo turntable is that it offers a reasonable technical performance which is compensated for by its excellent flexibility and almost faultless practical performance. Fitted with a high quality cartridge, and tracking at close to the upper limit recommended by the manufacturer, it will perform well and satisfy most residential uses. Given the benefit of a heavier plinth and/or located in a vibration-free area it would perform even better. ●

Dimension: 108 mm high x 480 mm wide x 384 mm deep
Weight: 9 kg
Manufactured by: Sharp Corporation, Osaka, Japan
Price: $499
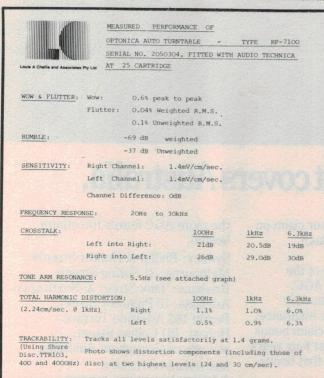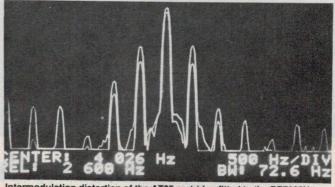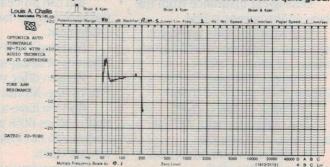
The Sharp-Optonica RP-7100H turntable is distributed by Sharp Corporation of Australia, 64 Seville St, Fairfield NSW.

MEASURED PERFORMANCE OF
OPTONICA AUTO TURNTABLE - TYPE RP-7100
SERIAL NO. 2050304, FITTED WITH AUDIO TECHNICA
AT 25 CARTRIDGE

Louis A Challis and Associates Pty Ltd

|				
WOW & FLUTTER:	Wow:	0.6% peak to peak		
	Flutter:	0.04% Weighted R.M.S.		
		0.1% Unweighted R.M.S.		
RUMBLE:		-69 dB	weighted	
		-37 dB	Unweighted	
SENSITIVITY:	Right Channel:	1.4mV/cm/sec.		
	Left Channel:	1.4mV/cm/sec.		
	Channel Difference:	OdB		
FREQUENCY RESPONSE:		20Hz to 30kHz		

CROSSTALK:

		100Hz	1kHz	6.3kHz
	Left into Right:	21dB	20.5dB	19dB
	Right into Left:	26dB	29.0dB	30dB

TONE ARM RESONANCE: 5.5Hz (see attached graph)

TOTAL HARMONIC DISTORTION:

		100Hz	1kHz	6.3kHz
(2.24cm/sec. @ 1kHz)	Right	1.1%	1.0%	6.0%
	Left	0.5%	0.9%	6.3%

TRACKABILITY: Tracks all levels satisfactorily at 1.4 grams.
(Using Shure Disc.TTR103, Photo shows distortion components (including those of 400 and 4000Hz) disc) at two highest levels (24 and 30 cm/sec).

CENTER: 4.026 Hz   500 Hz/DIV
REL: 2 600 Hz   BW: 72.6 Hz

Intermodulation distortion of the AT25 cartridge fitted to the RP7100H turntable. Taken with a 4 kHz signal, scale: 500 Hz per div., top trace taken at tracking velocity of 30 cm/sec, bottom at 23.8 cm/sec. Result is quite good.

Louis A. Challis & Associates Pty Ltd.
OPTONICA AUTO TURNTABLE RP-7100 WITH AUDIO TECHNICA AT 25 CARTRIDGE
TONE ARM RESONANCE
DATED: 20-9080

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WANTED: Members to enjoy sound magazines, printed magazines, round robins, tapespondence. Full details: The Tape Club of Australia, P.O. Box 118, Wellington, NSW 2820.

WANTED: 4-8 channel R-R tape recorder, any make, in good mechanical condition. Ring (070) 93-7331 or write to Swami Poornamurti, Satyananda Ashram, P.O. Kuranda, Qld 4872.

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214 ...	BP24	...	BP51	...	BP72	...
218 ...	BP33	...	BP52	...	BP73	...
219 ...	BP36	...	BP53	...	BP74	...
220 ...	BP37	...	BP54	...	BP75	...
221 ...	BP39	...	BP56	...	BP76	...
222 ...	BP40	...	BP57	...	BP79	...
223 ...	BP41	...	BP58	...	BP80	...

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By phone: We can only answer readers' technical enquiries by telephone **after 4.30 pm**. In enquiring by telephone about back issues or photostats. please ask for the "Subscriptions Department". 33-4282

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DREGS

That suit's still not airtight. I can smell the curried eggs he had for lunch!

NOW IT MAY BE TOLD. Some time during the 1950s, Time magazine sought to update their methods of reminding readers to renew their subscriptions. They called in the Addressograph-Multigraph Corporation to assist.

The resultant fully-automated machinery was duly set into motion — working its way through the multi-hundred thousand long mailing list — addressing and franking the cards — dutifully filling mail bag after mail bag until many hours later it completed its task — no doubt with a satisfied electro-mechanical sigh.

The following day was not good for a gentleman named Albert Abel.

In fact, it was very bad indeed.

For what the machine had done was to **address every one of the 500 000-plus reminders to Mr Abel** — and there was no way to turn them off!

Whilst astute enough to have been reading Time magazine, Mr Abel was not that bright either. So, after 250 000 or so reminders, he decided that Time magazine really **must** need his subscription — but by this time, the hallway of his modest abode was totally blocked by mail bags.

He finally phoned through a telegram. It ran:

"OK TIME MAGAZINE I GIVE IN".

To prevent us being sued by the local Addressograph-Multigraph company, we should point out that the above happened at A-M Los Angeles and that the story comes from that branch!

Better than 30-year-old Cabinet papers, what!

Punting the puns

Audio puns have come back into vogue, but digital puns still outstrip the field. R.D. of Mitcham in Victoria sent in a brace, including some audio-derived puns and one computer pun. Two audio puns are worth repeating; one on speakers: "People with class housings will not throw cones" and one on hi-fi (?): "One man's tweeter's another man's poissin (noise)". His best was on computing: "Don't PEEK until you POKE it"! Colin Jeffrey of Edithvale, also in Victoria, has the perfect answer for the family when they start grumbling about your computer project cluttering up the kitchen table. You say, "ROM wasn't built in a day . . .". On the same note, when asked who laid the founding stones of modern computing, don't say 'Charles Babbage' or the like, say "ROMulus and RAMus"! Then L.M.W. of Tamworth NSW had this one: "Love is like an AND gate" (. . . at this stage, we leave it to the readers to **imagine** what follows).

Clearly, R.D. of Mitcham wins this month.

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Sony's ICF-2001 brings home the world. Bon voyage.

AP3529